3X800 MW PATRATU STPP EXT.PH-I
PATRATU VIDYUT UTPADAN NIGAM LIMITED

VOLUME – II B & III

TECHNICAL SPECIFICATION
FOR
PRE TREATMENT PLANT (PT PLANT)

SPECIFICATION NO.: PE-TS-434-158A-A001 REV 01

BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA

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SECTION - A
INTENT OF SPECIFICATION

SCOPE OF INQUIRY/ INTENT OF SPECIFICATION:

1.1 This specification is intended to cover design, engineering, manufacture, fabrication, assembly, inspection & testing at vendor's & sub-vendor's works, painting, forwarding, supply and delivery at site including start up and commissioning spares, mandatory spares, properly packed for transportation, unloading / handling and storage at site, in site transportation, assembly, erection and commissioning, trail run, preparation and submission of "As Built" drawings, site testing, carrying out performance guarantee tests at site and handover of **PRE TREATMENT PLANT (PT PLANT)** including civil design & construction works of Pre Treatment Plant (excluding Chemical house & Centrifuge Shed/Building) as per the details in different sections / volumes of this specification for **3X800 MW PATRATU STPP.**

The bidder's scope shall also include any other services, etc. if called for in the succeeding sections of the specification.

1.2 The contractor shall be responsible for providing all material, equipment & services, which are required to fulfil the intent of ensuring operability, maintainability, reliability and complete safety of the complete work covered under this specification, irrespective of whether it has been specifically listed herein or not. Omission of specific reference to any component / accessory necessary for proper performance of the equipment shall not relieve them of the responsibility of providing such facilities to complete the supply, erection and commissioning of Pre Treatment Plant within quoted price.

1.3 It is not the intent to specify herein all the details of design and manufacture. However, the equipment shall conform in all respects to high standards of design, engineering and workmanship and shall be capable of performing the required duties in a manner acceptable to purchaser who will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material which in his judgment is not in full accordance herewith.

1.4 The extent of supply under the contract includes all items shown in the drawings, notwithstanding the fact that such items may have been omitted from the specification or schedules. Similarly, the extent of supply also includes all items mentioned in the specification and /or schedules, notwithstanding the fact that such items may have been omitted in the drawing.

1.5 Items though not specifically mentioned but needed to make the system complete as stipulated under these specifications are also to be furnished unless otherwise specifically excluded.

1.6 The general terms and conditions, instructions to tenderer and other attachment referred to elsewhere are made part of the tender specification. The equipment materials and works covered by this specification are subject to compliance to all attachments referred to in the specification. The bidder shall be responsible for and governed by all requirements stipulated herein.

1.7 While all efforts have been made to make the specification requirement complete & unambiguous, it shall be bidders' responsibility to ask for missing information, ensure completeness of specification, to bring out any contradictory / conflicting requirement in different sections of the specification and within a section itself to the notice of BHEL and to seek any clarification on specification requirement in the format enclosed under Vol-III of the specification as **"**PRE BID CLARIFICATION SCHEDULE". In absence of any such clarifications, in case of any contradictory requirement, the more stringent requirement as per interpretation of BHEL/Customer shall prevail and shall be complied by the bidder without any commercial and delivery implication on account of the same. Further in case of any missing information in the specification not brought out by the prospective bidders as part of pre-bid clarification, the same shall be furnished by BHEL/ Customer as and when brought to their notice either by the bidder or by BHEL/ customer themselves. However, such requirements shall be binding on the successful bidder without any commercial & delivery implication.

1.8 Deviations, if any, should be very clearly brought out clause by clause in the enclosed schedule; otherwise, it will be presumed that the vendor's offer is strictly in line with NIT specification.

1.9 In case all above requirements are not complied with, the offer may be considered as incomplete and would become liable for rejection.

1.10 Unless specified otherwise, all through the specification, the word contractor shall have same meaning as successful bidder/vendor and Customer/Purchaser/Employer will mean BHEL and/or Customer (NTPC: National Thermal Power Corporation Limited) as interpreted by BHEL in the relevant context. Please refer GCC/SCC for better clarity.

1.11 The equipment covered under this specification shall not be dispatched unless the same have been finally inspected, accepted and dispatch release issued by BHEL/Customer.

1.12 BHEL's/Customer's representative shall be given full access to the shop in which the equipments are being manufactured or tested and all test records shall be made available to him.

SECTION – B

PROJECT INFORMATION

SUB-SECTION–I-B

PROJECT INFORMATION

PATRATU STPS EXPANSION PHASE-I (3X800 MW)

1.00.00 BACKGROUND

A Memorandum of Agreement (MOA) has been entered on 29.07.2015 amongst Govt. of Jharkhand (GoJ), Jharkhand Urja Vikash Nigam Limited (JUVNL), Jharkhand UrjaUtpadan Nigam Limited (JUUNL), Jharkhand BijliVitaran Nigam Limited (JBVNL) and NTPC Limited to form a Joint Venture Company of NTPC Limted& JBVNL for transfer of Patratu Thermal Power Station (PTPS) located in Ramgarh District of Jharkhand State to the proposed JV Company for Performance Improvement of existing capacity & 4000 MW Capacity expansion of PTPS.

Further to signing of JV agreement on 29.07.2015, a Joint Venture Company namely Patratu Vidyut Utpadan Nigam Limited (PVUNL) has been incorporated amongst GoJ, JUVNL, JBVNL and NTPC Ltd. on 15.10.2015. The Performance Improvement of existing capacity and 4000 MW Capacity expansion of Patratu STPS will be implemented by the JV Company (JVC). The configuration of expansion of 4000 MW shall consist of 5 units of 800 MW to be implemented in two phases; Phase-I: 3x800 MW and Phase-II: 2x800 MW.

The present proposal is for Patratu STPS Phase-I (3x800 MW). The project is envisaged to be commissioned during XIII Plan period.

2.00.00 CAPACITY

Patratu STPS Phase-I: 3x800 MW - Present proposal

3.00.00 MODE OF OPERATION

Base Load

4.00.00 LOCATION AND APPROACH

4.01.00 Patratu Thermal Power station (PTPS) is located just outside the coal belt of South Karanpura in Ramgarh District of Jharkhand State. The nearest Railway Station is Patratu which is at a distance of about 4 km on Barkakhana-Barwadih Railway line.

4.02.00 **The latitudes and longitudes of the site are as follows:**

Corner name	Latitude	Longitude
Top Corner	23° 38 ‘ 60 ‘‘ N	85° 17’ 51.5” E
Bottom Corner	23° 38 ‘12.5 ‘‘ N	85° 17’ 27” E
Left Corner	23° 38 ‘ 22.5 ‘‘ N	85° 17’ 10.6 ‘‘ E
Right Corner	23° 38 ‘ 40 ‘‘ N	85° 17’ 57 ‘‘ E

4.03.00 **Airport**

The nearest commercial airport is Ranchi at about 45 km by road.

A copy of Vicinity plan of the project site is placed at **Annexure - I**.

5.00.00 LAND

The total land to be transferred to JV Company is 1859 acres. Out of 1859 acre, about 1234 acres of land has been envisaged for Plant, Ash pond and Land on railway track of the for Phase-I (3x800 MW). The balance 625 acre of land shall be transferred during commencement of Phase-II (2x800 MW).

6.00.00 WATER

The make-up water for PSTPS is to be met from Patratu Dam on Nalkari River (capacity 99 MCM i.e. 110 Cusecs). About 52.34 Cusecs of water will be available at 90% dependable monsoon flow after considering evaporation loss.

GoJ/JUVNL owns and controls water of Patratu Dam. GoJ/JUUNL supplies water to PTPS and to the other entities in the vicinity from this water reservoir. JUVNL had entered into agreements with these other entities for supply of water from water reservoir. JUVNL shall revisit these agreements to meet the requirement of water for expansion projects, if required.

Make up water requirement of PSTPS, Phase-I (3x800 MW) would be about 27 Cusecs with “Air Cooled Condenser” based power plant. GoJ shall provide the required water from the existing reservoir to the JV Company.

The JVC shall be responsible for the water supply arrangement starting at the downstream of intake chamber from where water supply commences for the Station. Ownership of the entire water supply system and related plant and equipment, including the water treatment plant, shall be that of the JVC and after the asset transfer, the JVC shall maintain, take care and use the same. The additional facility including addition of plant, equipment etc. for enhanced requirement (if any) and drawl of water shall be the responsibility of JVC and to be arranged by the JVC at their own cost.

7.00.00 COAL

7.01.00 **Coal Requirement, Availability and Linkage**

About 12 MTPA of coal will be required to meet coal requirement of the Phase-I (3x800 MW) of the project.

The Banhardih captive coal block at a distance of about 155 km from plant is allocated to JUVNL for end use of Patratu expansion. The coal from Banhardih captive coal block shall be transferred to the JVC for the usage of PSTPS with the approval of Ministry of Coal, GOI. MOC (11.09.15) has accorded in-principle approval of the Central Govt. to assign Banhardih Coal Block allocated to JUVNL to the JV Company.

7.02.00 **Coal Transportation**

The envisaged mode of coal transportation from the coal mines to the power plant is by Indian Railways through BOBR / BOX- N wagons.

7.03.00 **Coal Quality**

The primary fuel for the main steam generator shall be coal. The domestic coal quality parameters are indicated in **Annexure-IV-2** and imported coal parameters are indicated in **Annexure-IV-4** are to be considered for steam generator design.

7.04.00 **Fuel Oil**

The fuel oils to be used for start-up, coal flame stabilization and low load operation of the steam generator shall be Heavy Fuel Oils having the characteristics given at **Annexure-IV-3**and Light Diesel Oil having the characteristics given at **Annexure-IV-1.**

8.00.00 NOT USED

9.00.00 STEAM GENERATOR TECHNOLOGY

The steam generators shall be super critical once through type, water tube, direct pulverized coal fired, top supported, balanced draft furnace, single reheat, radiant, dry bottom type, suitable for outdoor installation. The gas path arrangement shall be single pass (Tower type) or two pass type.

10.00.00 FLUE GAS DESULPHURIZATION SYSTEM (FGD) &SCR:

The project is envisaged with Flue Gas Desulfurization (FGD) system and SCR meeting Ministry of Environment, Forest & Climate Change notification dated 07.12.2015. Limestone to be used for design of FGD system shall be as per the characteristic given at Annexure-IV-5.

11.00.00 POWER EVACUATION SYSTEM

85% of power from the project is envisaged to be allocated to Jharkhand State subject to approval of Ministry of Power, while balance 15% would be as unallocated portion and Project is envisaged as regional project. Since major power (85%) is proposed to be absorbed by Jharkhand, the issue of Associated Transmission

System for the project would be taken up with them for planning and execution of transmission system modalities as Inter-State System or ISTS System.

Considering overall capacity of the project as 4000 MW, 765 kV step-up system has been envisaged. Two D/C 765 KV line, one each to New Ranchi (Bero) and Gaya has been envisaged. This would also form part of 765 kV transmission corridor connecting Ranchi to Gaya. These lines can be used to evacuate power to the Eastern Region ISTS as well as to Jharkhand State. In view of above, provision of four nos. of 765 kV outgoing Line bays has been kept in the new 765 kV generation switchyard.

The issue of power evacuation of the proposed project shall be taken up with appropriate Transmission Utility (STU or CTU) as per regulatory provision, based on allocation of power.

12.00.00 METEOROLOGICAL DATA

The meteorological data from nearest observatory is placed at **Annexure-II.**

13.00.00 PLANT WATER SCHEME

The Plant water scheme is described below.

13.01.00 **Equipment Cooling Water (ECW) System (Unit Auxiliaries)**

The plant auxiliaries of Steam Generator and Turbine Generator shall be cooled by Demineralized (DM) water in a closed circuit. The primary circuit DM water shall be cooled through plate type heat exchangers by Circulating Water tapped from ACW system in a secondary circuit. The station auxiliaries such as Air compressors, Compressors of ash handling plant, compressor of mill reject system etc. shall also be cooled by Demineralized (DM) water in a closed circuit .The hot secondary circuit cooling water shall be cooled in the cooling towers and shall be returned back to the system. It is proposed to provide independent primary cooling water circuit for Steam Generator & auxiliaries and TG & its auxiliaries.

13.02.00 **Not used**

13.03.00 **Other Miscellaneous Water Systems**

(a)The drinking water requirement of the plant shall be provided from water treatment plant.

(b) Steam Cycle make-up water, makeup to the primary circuit of ECW (unit auxiliaries) system, boiler fill water shall be provided from demineralizing plant.

(c) The quality of Raw Water & DM Water is enclosed with this sub-section as **Annexure-III**.

(d) Effluent from various areas in TG & SG system shall be collected in respective pits in their areas and pumped to a common terminal point as shown in plant water scheme.

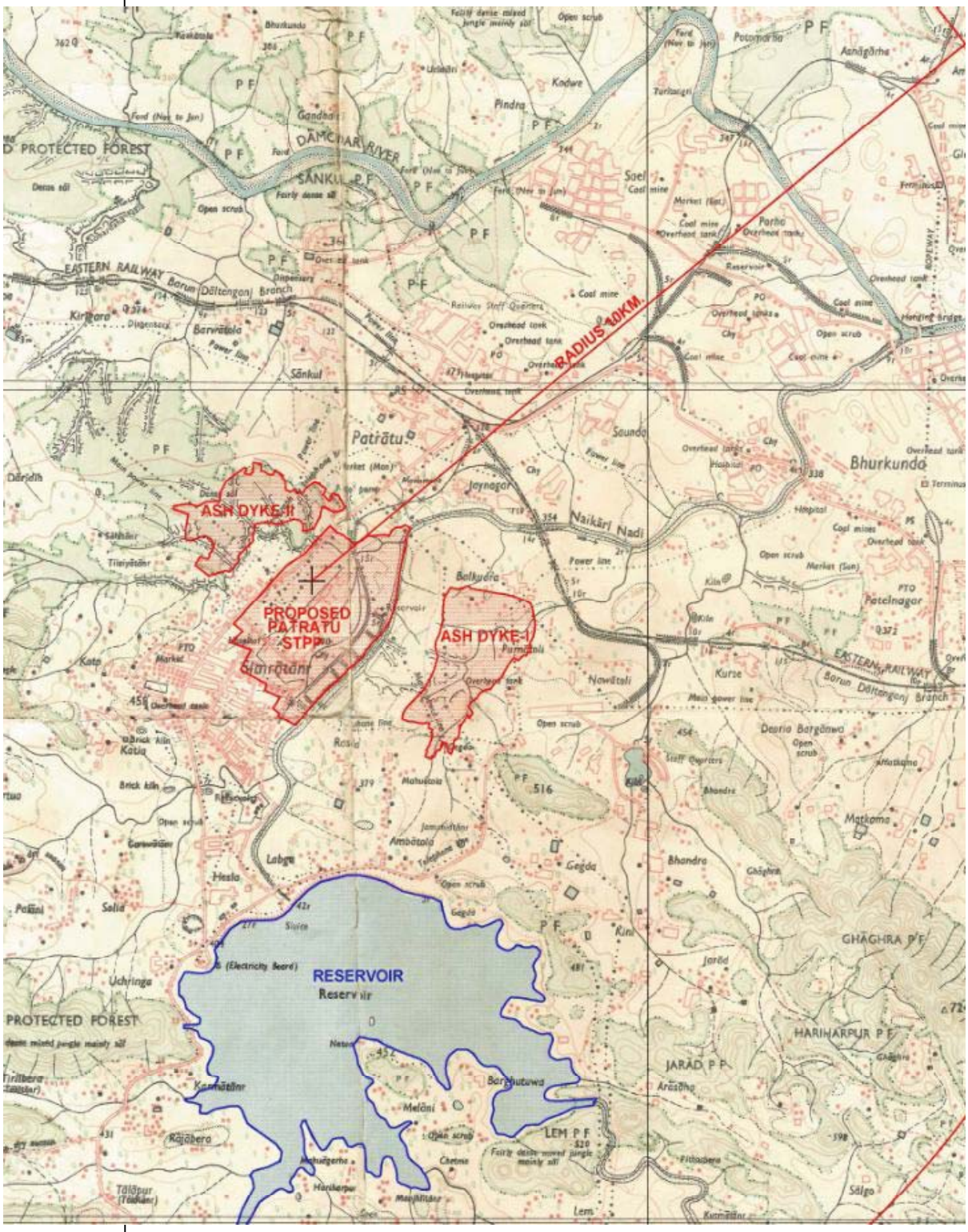
14.00.00 CRITERIA FOR EARTHQUAKE RESISTANT DESIGN OF STRUCTURES AND EQUIPMENT

All power plant structures and equipment, including plant auxiliary structures and equipment shall be designed for seismic forces as given in Part-B of this section.

15.00.00 CRITERIA FOR WIND RESISTANT DESIGN OF STRUCTURES AND EQUIPMENT

All structures and equipment of the power plant, including plant auxiliary structures and equipment, shall be designed for wind forces as given as given in Part-B of this section.

ANNEXURE-I


RADIUS 10KM.
ASH DYKE-II
PROPOSED PATRATU STPP
ASH DYKE-I
RESERVOIR
Reservoir
PROTECTED FOREST
DAMODAR RIVER
EASTERN RAILWAY
Barun Daltengonj Branch
Patratu
Bhurkunda
Jaynagar
Naikari Nadi
Sankul
Barwadih
Kirtiara
Kodwe
Pindra
Potomarba
Aandgarha
Parbo
Saunda
Belkydra
Nawatali
Kurse
Patelnagar
Matkoma
Bhandra
Gegda
Labga
Amatola
Hesla
Salia
Uchringa
Kanhatanr
Melani
Rajabera
Talapur
Harriharpur
Lem
Sargo
GHAGHRA P F
HARIHARPUR P F
JARAD P F
LEM P F
Desria Bargawa
Kiri
Jarad
Arasaha
Fitkabera
Sargo
Kutia
Brick kiln
Sanrotani
Kato
Tilaiyatanr
Sanhatanr
Daridih
Ford (Not to Jun)
Dispensary
Railway Staff Quarters
Coal mine
Overhead tank
Power line
Open scrub
Fairly dense mixed jungle mainly sal
Dense sal
Fairly dense sal
Market (Sat.)
Hospital
PO
Chy
PS
PTO
Terminus
Kiln
Staff Quarters
Bhandra
Ghaghra
Arasaha
Fitkabera
Sargo
Lem
Harriharpur
Maniltanr
Chatma
Mahuatola
Jamadihtanr
Gegda
Kini
Jarad

ANNEXURE-II

C

जलवायवी सारणी
CLIMATOLOGICAL TABLE

1953 से 1980 तक के वर्षों पर आधारित
BASED ON OBSERVATIONS FROM 1953 TO 1980

स्टेशन : रामगढ़ STATION : Ramgarh — अक्षांश LAT 23°36′ N — देशांतर LONG 85°30′ E — समुद्री तल सतह से ऊँचाई HEIGHT ABOVE M.S.L. 335 METRES

माह MONTH		स्टेशन का तल पर दाब STATION LEVEL PRESSURE hPa	वायु तापमान AIR TEMPERATURE												वर्षा RAINFALL							
			माध्य MEAN						चरम EXTREMES				आर्द्रता HUMIDITY		मेघ सीकरण CLOUD AMOUNT							
			शुष्क DRY BULB	नम WET BULB	दैनिक अधिकतम का माध्य DAILY MAX	दैनिक न्यूनतम का माध्य DAILY MIN	माह में उच्चतम HIGHEST IN THE MONTH	माह में निम्नतम LOWEST IN THE MONTH	उच्चतम HIGHEST	दिनांक और वर्ष DATE AND YEAR	निम्नतम LOWEST	दिनांक और वर्ष DATE AND YEAR	सापेक्ष आर्द्रता RELATIVE HUMIDITY	वाष्प दाब VAPOUR PRESSURE	समस्त मेघ ALL CLOUDS	निम्न मेघ LOW CLOUDS	औसत वर्षा MONTHLY TOTAL	वर्षा के दिनों की संख्या NO. OF RAINY DAYS	अधिकतम वर्षा का महीने का योग TOTAL IN WETTEST MONTH WITH YEAR	अधिकतम वर्षा का सबसे सूखे महीने का योग TOTAL IN DRIEST MONTH WITH YEAR	24 घंटों की सबसे भारी वर्षा HEAVIEST FALL IN 24 HOURS	दिनांक और वर्ष DATE AND YEAR	MEAN WIND SPEED
		hPa	°C	°C	°C	°C	°C	°C	°C		°C		%	hPa	Oktas of sky	Oktas of sky	mm		mm	mm	mm		Km/h
जनवरी JAN	I		14.6	11.9	24.5	8.2	28.5	3.7	33.4	31 1967	1.2	05 1978	58	11.8	1.2	0.6	16.7	1.7	52.3 1953	0.0	42.0	04 1956	2.9
	II		20.2	15.2									55	13.3	1.3	0.7							
फरवरी FEB	I		17.1	13.3	27.6	10.5	32.7	5.5	37.8	24 1967	3.0	10 1978	52	12.4	1.0	0.5	19.3	1.3	94.0 1961	0.0	54.0	08 1961	2.8
	II		23.5	16.6									48	13.4	1.5	0.6							
मार्च MAR	I		23.5	17.2	33.0	15.1	37.3	10.4	41.4	29 1965	7.0	11 @ 1979	50	14.6	1.5	0.4	11.4	1.2	30.4 1956	0.0	23.2	06 1952	3.3
	II		29.3	18.7									35	14.3	1.5	0.6							
अप्रैल APR	I		30.2	21.3	38.4	21.0	42.3	15.6	45.2	16 1973	13.5	07 1957	42	18.5	1.2	0.4	16.0	1.4	52.7 1952	0.0	41.0	01 1950	4.3
	II		34.5	22.1									34	16.7	1.8	0.8							
मई MAY	I		32.6	24.1	40.8	24.5	44.8	20.0	48.0	11 1973	17.0	06 @ 1979	47	22.2	1.6	0.6	28.7	2.3	136.6 1959	0.0	76.4	28 1950	4.5
	II		36.3	24.3									38	23.7	2.4	1.2							
जून JUN	I		30.9	25.5	37.5	23.5	43.2	21.7	47.8	12 1965	19.5	01 1979	62	24.3	3.5	1.5	129.4	7.4	332.4 1961	13.4 1973	140.0	07 1961	4.9
	II		32.0	25.5									62	27.3	4.4	2.3							
जुलाई JUL	I		28.1	25.4	32.3	24.3	37.3	22.1	46.5	1961	20.0	09 @ 1974	77	30.3	5.5	4.0	289.9	16.5	565.3 1980	131.9 1966	205.2	18 1950	4.2
	II		28.9	25.7									77	30.6	5.6	4.1							
अगस्त AUG	I		27.6	25.3	31.7	24.1	35.3	22.1	38.0	05 1973	18.2	20 1960	78	30.5	5.3	3.5	286.7	15.8	616.0 1953	54.0 1974	169.9	24 1953	3.5
	II		28.3	25.8									81	31.1	5.6	3.7							
सितम्बर SEP	I		27.2	24.8	31.6	23.0	35.0	21.1	38.0	05 1974	18.9	30 1957	79	29.5	5.5	3.0	253.8	11.4	720.8 1957	92.7 1955	159.1	01 1957	3.1
	II		27.8	25.3									81	30.2	5.9	3.4							
अक्टूबर OCT	I		24.9	22.1	31.4	19.1	34.4	14.4	38.0	02 1970	10.6	27 1966	74	21.4	2.4	1.4	91.7	4.2	265.7 1963	2.6 1979	134.4	12 1973	2.0
	II		26.7	23.2									74	25.3	2.8	1.6							
नवम्बर NOV	I		19.6	16.3	28.3	12.4	31.5	8.2	35.1	01 1973	5.4	23 1960	68	15.9	0.9	0.2	3.5	0.5	77.5 1948	0.0	34.3	07 1948	1.8
	II		22.8	18.4									60	17.9	1.1	0.5							
दिसम्बर DEC	I		14.7	12.1	24.5	8.3	28.6	4.0	32.0	01 1971	0.6	24 1961	68	12.0	0.9	0.4	2.7	0.3	56.4 1950	0.0	56.4	28 1950	1.7
	II		15.6	15.3									69	13.9	1.2	0.6							
वार्षिक योग ANNUAL TOTAL OR MEAN	I		24.3	19.9	31.8	18.0	44.9	3.0	48.0		0.6		65	21.0	2.4	1.4	1098.2	64.9	1440.1 1961	794.7 1955	205.2		3.2
	II		27.5	21.4									59	21.3	2.8	1.7							
वर्षों की संख्या NUMBER OF YEARS	I		23	23	21	21	21	21	22		22		24	23	22	17	26	26	27	27	27		16
	II		24	24									24	24	23	17							

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ANNEXURE-II

जलवायवी सारणी
CLIMATOLOGICAL TABLE

स्टेशन : रामगढ़
STATION : Ramgarh

MONTH	RPT 0.3mm or more	HAIL	THUN DER	FOG	DUST STORM	SQU ALL	62 or more	20-61	1-19	0	N	NE	E	SE	S	SW	W	NW	CA LM	0	T-2	3-5	6-7	8	FOG	UP TO 1 Km	1-4 Kms	4-10 Kms	10-20 Kms	OVER 20 Kms
जनवरी JAN	2.9	0.0	0.2	0.2	0.0	0.0	0	0	19	12	6	2	3	7	8	33	5	23	13	225	22	2	1	1	0	0.1	1.9	14.3	9.0	57.7
फरवरी FEB	2.1	0.1	0.9	0.1	0.0	0.0	0	0	13	18	2	2	5	3	5	20	2	11	10	225	22	2	1	1	0	0.2	2.1	12.4	9.5	58.8
मार्च MAR	1.7	0.1	1.6	0.0	0.5	0.0	0	0	21	16	5	1	3	3	11	12	33	4	18	24	1	1	1	1	0	0.1	3.3	10.6	8.4	56.6
अप्रैल APR	2.4	0.0	1.6	0.1	1.3	0.0	0	0	22	9	6	3	13	1	10	8	38	5	16	23	2	1	1	0	0	0.0	2.6	11.0	7.6	56.5
मई MAY	3.5	0.1	2.9	0.0	0.8	0.2	0	0	21	9	7	2	14	2	9	6	39	6	13	25	2	1	1	0	1	0.2	1.4	11.1	10.9	58.5
जून JUN	10.4	0.1	4.4	0.0	1.4	0.1	0	0	23	8	6	5	24	3	6	5	31	6	11	24	2	0	0	0	0	0.3	1.4	10.3	11.9	57.6
जुलाई JUL	12.3	0.6	5.9	0.0	0.9	0.0	0	0	24	6	6	5	34	5	8	7	23	8	3	15	3	5	3	4	0	0.3	1.2	10.9	10.9	57.4
अगस्त AUG	17.8	0.5	4.8	0.1	0.0	0.0	0	0	24	8	7	4	35	5	6	5	21	4	13	11	0	4	4	6	0	0.0	1.2	10.9	10.9	58.1
सितम्बर SEP	12.9	1.0	3.2	0.2	0.0	0.0	0	0	21	10	6	5	36	6	9	7	17	3	12	12	2	2	2	6	0	0.0	0.6	10.1	8.4	58.1
अक्टूबर OCT	5.2	0.0	1.3	0.1	0.0	0.0	0	0	21	10	5	3	20	2	11	7	31	5	16	22	2	2	3	4	0	0.2	0.8	8.0	8.4	58.4
नवम्बर NOV	0.7	0.0	0.0	0.7	0.0	0.0	0	0	14	17	6	3	24	1	7	2	19	3	33	20	2	1	1	2	0	0.0	0.4	10.1	8.6	58.3
दिसम्बर DEC	0.5	0.1	0.1	0.2	0.0	0.0	0	0	21	10	8	2	9	1	6	10	38	6	20	24	2	2	1	1	0	0.0	1.6	14.7	3.6	58.5
									12	19	14	0	8	0	6	1	20	6	45	24	1	1	1	1	0	0.0	1.7	16.1	4.7	58.5
वर्षभर में NUMBER OF YEARS	21						0	0	255	119	6	4	21	3	8	8	30	5	15	245	20	33	23	44	276	16	25	11	35	0	0.9	41.8	134.7	100.4	572
							0	1	224	140	8	3	21	4	7	4	22	7	24	234	18	36	25	52	256	20	35	13	41	0	2.2	48.1	1292	105.8	797
वर्षभर में NUMBER OF YEARS	21						16				20									15					15						
							16				20									15					15						

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ANNEXURE-III

RAW WATER ANALYSIS

S.No	Constituent	As	mg/l
1	Calcium	$CaCO_3$	105
2	Magnesium	$CaCO_3$	81
3	Sodium	$CaCO_3$	70
4	Potassium	$CaCO_3$	7
	Total cations	$CaCO_3$	263
5	M- Alkalinity	$CaCO_3$	180
6	P- Alkalinity	$CaCO_3$	0
7	Chloride	$CaCO_3$	60
8	Sulphate	$CaCO_3$	23
	Total Anions	$CaCO_3$	263
9	Total Silica, Reactive Silica, Reactive Silica, Colloidal	SiO_2	17 15 2
10	Iron (Total)	Fe	0.5
11	pH	-	7.0-7.8
12	Turbidity	NTU	100
13	Total dissolved solids		350-400
14	Temperature	Deg C	20-35
15.	TOC		1.93
16.	BOD		8
17.	COD		14
18.	Total Suspended Solids	mg/l	100

ANNEXURE-III

THE MINIMUM QUALITY OF DM WATER TO BE CONSIDERED FOR MAKE-UP WATER

Sl.No.	Characteristics	Value
1.	Silica (Max.)	0.02 ppm as Sio2
2.	Iron as Fe	Nil
3.	Total hardness	Nil
4.	pH value	6.8 -7.2
5.	Conductivity	Not more than 0.1micro mho/cm excluding the effects of free CO2

ANNEXURE-IV-1

LIGHT DIESEL OIL CHARACTERISTICS

AS PER IS 15770-2008

	Characteristics	LDO
1.	Pour Point (max)	21 °C & 12°C for Summer and Winter respectively
2.	Kinematic viscosity in centistokes at 40 deg.C	2.5 to 15.0
3.	Sediment percent by mass (max)	0.10
4.	Total sulphur percent by mass (max)	1.5
5.	Ash percentage by mass (max)	0.02
6.	Carbon residue (Rams bottom) percent by pass (max.)	1.50
7.	Acidity inorganic	Nil
8.	Flash point (Min.) - Pensky Martens	66 deg.C
9.	Copper strip corrosion for 3 hours at 100°C	Not worse than No. 2
10.	Water content, % by volume (max)	0.25
11.	GCV(kcal/kg)	10,000

ANNEXURE-IV-2

DOMESTIC COAL CHARACTERISTICS

S No.	Characteristics (As received basis)	Range of 95% coal supplies			Range of 5% coal supplies	
		Column-1	Column-2	Column-3	Range of Adequacy coal	
1.0	**PROXIMATE ANALYSIS**	**Design**	**Worst**	**Best**	**Worst**	**Best**
1.1	Total Moisture (%)	14	17	11	18	10
1.2	Ash (%)	36	42	34	44	30
1.3	Volatile matter (%)	23	19	24	19	28
1.4	Fixed carbon (%)	27	22	31	19	32
2.0	**ULTIMATE ANALYSIS**					
2.1	Carbon (%)	33.31	27.23	39.07	25.72	44.43
2.2	Hydrogen (%)	3.49	3.05	3.53	2.93	3.72
2.3	Sulphur (%)	0.6	0.9	0.5	0.95	0.35
2.4	Nitrogen (%)	0.9	1.3	0.8	1.4	0.6
2.5	Oxygen (%) (By difference)	11.7	8.52	11.1	7	10.9
2.6	Total Moisture (%)	14	17	11	18	10
2.7	Ash (%)	36	42	34	44	30
2.8	GCV (kcal/kg)	3400	2900	3900	2800	4400
2.9	Hard Grove index	55	50	60	45	65
2.10	YGP Index (mg/kg)	75	80	70	85	65
2.11	Carbonates	0.3	0.38	0.27	0.2	0.43
2.12	Phosphorous	0.05	0.04	0.06	0.03	0.07
2.13	Chloride	0.08	0.15	0.05	0.18	0.04
2.14	Trace Elements (ppm)					
2.14.1	Arsenic	1	1.5	0.5	2.5	0.4
2.14.2	Lead	35	75	25	150	10
2.14.3	Mercury	0.1	0.5	0.08	0.6	0.06
2.14.4	Selenium	0.8	1	0.6	1.5	0.5
3.0	**ASH ANALYSIS**					
3.1	Silica (%)	59.25	63.4	56.92	63.56	54.2
3.2	Alumina (%)	27.62	27.29	28.47	27.2	29.89
3.3	Iron Oxide (%)	6.75	5.48	7	5.46	7.5
3.4	Titania (%)	1.95	0.88	2.5	0.98	2.82
3.5	P_2O_5(%)	0.24	0.3	0.11	0.35	0.1
3.6	Lime (%)	0.9	0.7	1.5	0.6	1.6
3.7	Magnesia (%)	0.2	0.3	0.15	0.35	0.1
3.8	Sulphuric Anhydride (%)	1.2	0.5	1.4	0.4	1.7
3.9	Sodium Oxide (%)	0.17	0.25	0.15	0.3	0.15
3.10	Balance Alkalies (By Difference) (%)	1.72	0.9	1.8	0.8	1.94
4.0	**ASH FUSION RANGE** (Under reducing atmosphere)					
4.1	Initial Deformation Temperature (°C)	1100	1100	1100	1100	1100
4.2	Hemispherical temperature (°C)	1300	1250	1350	1250	1350
4.3	Flow temperature (°C)	1400	1400	1400	1400	1400

ANNEXURE-IV-3

FUEL OIL CHARACTERISTICS

Sl. No.	Characteristics	Heavy Furnace Oil grade HV (HFO) IS-1593-1982	Low Sulphur Heavy Stock (LSHS) IS-11489-1985	Heavy Petroleum stock (HPS) IS-11489-1985
1.	Total sulphur content	4.5% Max.	1.0% Max.	4.5% Max.
2.	Gross calorific value (KCal/kg)	of the order of 10,000	of the order of 10,000	of the order of 10,000
3.	Flash Point (Min)	66 deg C	76 deg C	66 deg C
4.	Water content by volume (Max)	1.0%	1.0%	1.0%
5.	Sediment by weight (Max)		0.25%	0.25% 0.25%
6.	Asphaltene content by weight (Max.)	2.5%	2.5%	2.5%
7.	Kinematic viscosity in Centistokes	370 at 50deg C	100 at 100deg C	100 at 100deg C
8.	Ash Content by weight (Max.)	0.1%	0.1%	0.1%
9.	Acidity (inorganic)	Nil	Nil	Nil
10.	Pour Point (Max.)	57 deg C	66 deg C	72 deg C
11.	Sodium content	—	—	100 ppm
12.	Vanadium content	25 ppm	25ppm	25 ppm
13.	Specific heat below pour point (KCal/Kg °C)		0.65	

ANNEXURE-IV-4

TYPICAL IMPORTED COAL AND ASH CHARACTERISTICS

Sl.No.	Characteristics (as received basis)	Imported Coal	
		Worst	Best
1.0	**Proximate Analysis**		
1.1	Total Moisture (%)	20	16
1.2	Ash (%)	10	10
1.3	Volatile Matter (%)	30	45
1.4	Fixed Carbon (%)	40	29
1.5	Total (%)	100	100
2.0	**Ultimate Analysis**		
2.1	Carbon (%)	56.4	62.4
2.2	Hydrogen (%)	4.5	4.9
2.3	Sulphur (%)	0.9	0.8
2.4	Nitrogen (%)	0.9	0.5
2.5	Oxygen (%) (By difference)	7.3	5.4
2.6	Carbonates (%)	0	0
2.7	Phosphorous (%)	0	0
2.8	Total Moisture (%)	20	16
2.9	Ash (%)	10	10
	Total	100	100
2.10	GCV (Kcal/Kg)	5800	6500
2.11	Hard Grove Index	45	60
2.12	YGP (mg/kg)	100	70
3.0	**Ash Analysis**		
3.1	Silica (SiO_2) (%)	32.74	34.94
3.2	Alumina(Al_2O_3) (%)	30.5	28.43
3.3	Iron Oxides(Fe_2O_3) (%)	18.2	15.2
3.4	Titania (TiO_2)	1.56	1.76
3.5	Phosphoric Anhydride(P_2O_5) (%)	0.44	0.54
3.6	Lime (CaO) (%)	6.12	7.62
3.7	Magnesia (MgO) (%)	1.83	1.93
3.8	Sulphuric Anhydride (%)	6.95	7.65
3.9	Sodium Oxide (Na_2O) (%)	0.3	0.4
3.10	Balance alkalies (by difference)	1.36	1.56
	Total	100	100
4.0	**Ash Fusion Temperature reducing temperature**		
4.1	Initial deformation Temp (℃)	1100	1250
4.2	Hemispherical Temp. (℃)	1300	1350
4.3	Flow Temp. (℃)	1400	1400

ANNEXURE-IV-5

LIMESTONE CHARACTERISTICS

The details of Limestone data shall be furnished later.

SECTION-C1
(SPECIFIC TECHNICAL REQUIRMENT-MECHANICAL)

1.0 GENERAL

This specification is intended to cover design, engineering, manufacture, fabrication, assembly, inspection & testing at vendor's & sub vendor's works, painting, forwarding, supply and delivery at site including start up and commissioning spares, mandatory spares, operation & maintenance spares, as required, properly packed for transportation, loading/unloading / handling and storage at site, in site transportation, assembly, erection and commissioning, trial run, preparation and submission of drawing/documents including "As Built" drawings, site testing, carrying out performance guarantee tests at site and handover in flawless operating condition to end customer the entire Pre Treatment Plant complete with all accessories including including civil design & construction works of Pre Treatment Plant (excluding Chemical house & Centrifuge Shed/Building) for **3X800 MW PATRATU STPP EXT.PH-I .**

Civil design & construction works of Pre Treatment Plant (Excluding Chemical house & Centrifuge Shed/Building) shall be in Bidder's scope.

2.0 REFERENCE DOCUMENTS

A.	PE-DG-434-158A-A001	:	P & ID FOR PRE TREATMENT PLANT
B.	DATASHEET – A	:	FOR ABOVE SYSTEM
C.	PE-DG-434-100-M001	:	PLOT PLAN
D.	PE-DG-434-158A-A001A	:	LAYOUT OF PRETREATMENT PLANT

3.0 SCOPE OF SUPPLY (MECHANICAL & CIVIL)- Please also refer Section C4 (Specific Technical requirement -Civil) for civil scope.

Bidder to note that Pre-treatment Plant for auxiliary cooling water system (PT-CW) ,DM system (PT-DM) & potable water system (PT-Potable) shall include associated Mechanical, Electrical, Control & instrumentation work. All the work i.e. Mechanical work, C&I, Electrical works (refer electrical, C&I for respective scope), Broad scope of supply has been listed below:-

1) Raw water inlet piping to each aerator complete with piping, fitting and valves. The each inlet piping is to include motorized butterfly type control valve with manual upstream and downstream isolation valves along with by-pass motorized butterfly valve with necessary instrumentation.

2) Two (2) number Aerator and Two (2) number stilling chamber of RCC Construction of required capacity along with isolation gates at the inlet to the inlet channels for PT-ACW & PT-DM system clarifiers.

3) Channel from Aerator to Stilling Chamber as per P & ID enclosed for pre-treatment plant.

4) Three (3) numbers of inlet channels with flow measuring element in each channel (parshall flume) of RCC Construction.

5) One (1) number bypass channel of RCC Construction to by-pass PT-ACW clarifier(s) with required isolation gate(s).

6) One (1) number bypass channel of RCC Construction to by-pass PT-DM clarifier with required isolation gate(s).

7) Three (3) nos. High Recovery Solid Contact Type Clarifiers with sampling points at different elevation of clarifiers. (02 Nos. For PT-CW & 01 No. for PT-DM as detailed in specification.)

8) Clarifiers bridges assemblies, hand railings, required motors, valves, piping, insert plates, instrumentation etc.

9) Outlet channels of RCC Construction from Clarifiers up to the Clarified Water Storage Tank/Clarified water distribution chamber, PT-DM & PT Potable Gravity Filters.

10) Interconnection between the clarified water outlet channel and outlet channel of PT-DM System.

11) Sludge disposal system from clarifiers, with piping, valves, instrumentation up to sludge collection pit as indicated in P & ID of Pre-treatment plant.

12) One (1) no. RCC Sludge Pit (in twin section) with common sump interconnected through valves.

13) Two (2) Air Blowers for air agitation system of the sludge pit & backwash sump with acoustic enclosure, piping, valves, instrumentation etc.

14) Three (3) nos. Sludge Feed Pumps with piping, valves, fittings and instrumentation up to thickener.

15) One (1) number of Sludge thickener of required capacity, pumps, associated valves, piping etc..

16) Two (2) nos. Sludge transfer pumps to thickened waste sumps with piping, valves, fittings and instrumentation up to thickened waste sump.

17) One (1) no. RCC thickened waste/sludge sump (in twin section) with common sump interconnected through valves.

18) Three (3) nos. Sludge disposal pumps with piping, valves, fittings and instrumentation up to Centrifuge.

19) Two (2) number of air blowers of oil free type of required capacity, its drives and associated accessories, air (Galvanised CS) piping from blowers to each section of the Thickened waste sump for air scouring of sump.

20) Centrifuge/filter press (2x50%) of required capacity, pumps, associated valves, piping etc.

21) Two (2) nos. Gravity Filters (twin section) of RCC construction including necessary shuttering plates & filter medium with piping, Nozzles, instruments, valves, etc. up to Filter Water Reservoir of potable water.

22) One (1) number filtered water reservoir (in twin sections located below the filters) of RCC Construction of each of required capacity, filtered water sump and common filtered water pump house for PT–Potable water & PT-DM systems.

23) Three (3) number of air blowers of oil free type of required capacity, its drives and associated accessories, air (Galvanised CS) piping from blowers to each section of the PT- Potable Gravity filters for air scouring of filters during backwash operation.

24) Two (02) Nos Potable Water Pumps for Plant along with motors, piping, valves, fittings, instrumentation etc.

25) Two (02) Nos Potable Water Pumps for Colony along with motors, piping, valves, fittings, instrumentation etc.

26) Two (2) nos. Gravity Filters (twin section) including necessary shuttering plates & filter medium with piping, instruments, valves, etc. up to Filter Water Reservoir of DM plant.

27) One (1) number filtered water reservoir (in twin sections located below the filters) of RCC Construction of each of required capacity, filtered water sump and common filtered water pump house for PT–Potable water & PT-DM systems.

28) Three (3) number of air blowers of oil free type of required capacity, its drives and associated accessories, air (Galvanised CS) piping from blowers to each section of the PT- DM Gravity filters for air scouring of filters during backwash operation.

29) Required interconnecting air (Galvanised CS) piping, valves, instrumentation etc from the blowers to each Gravity filter for air scouring of filters during backwash operation for both PT-Potable & PT-DM Gravity Filters.

30) One (1) number electrically operated monorail hoist along with mono rail and trailing cable (common for both PTDM & PT-Potable System) in gravity filters pump house of required capacity for handling all the pumps, blowers, drives etc.

31) One (1) number electrically operated monorail hoist along with mono rail and trailing cable (common for both PTDM & PT-Potable System) in gravity filters pipe gallery of required capacity for handling all the valves etc.

32) Pipe & Valves to facilitate future expansion for both PT DM & PT-Potable System, as detailed in tender specification.

33) One (1) no. RCC Filter Backwash Pit (in twin section) for both PTDM & PT-Potable System with common sump interconnected through valves.

34) Two (2) nos. Filter Backwash Pumps with piping, valves, fittings and instrumentation up to Stilling Chambers of PT-ACW & PT-DM Clarifiers.

35) One (1) no. two story chemical house building to store chemicals, tanks, pumps, etc. for both Pretreatment plant & effluent treatment plant. The Civil Design & Construction work of Chemical House shall be in the scope of BHEL. However the chemical tanks (Other than RCC) , dosing pumps, transfer pumps, instruments, piping, valves, platforms along with handrails, weighing & handling equipment, ladders, piping supports, auxiliary structures for pipe fixing etc. along with all structural steel, inside the chemical house shall be in the scope of bidder.

36) Two (2) nos. Lime slaking tanks (RCC Construction is in BHEL's Scope) with motorized stirrer, flushing arrangement, instrumentation, valves, fittings and piping up to the Lime preparation tank.

37) Two (2) nos. Lime slurry transfer Pumps with Piping, valves & instrumentation etc.

38) Three (3) nos. Lime Solution dosing Tanks with motorized stirrer, flushing arrangement, instrumentation, valves, fittings and piping up to the Clarifiers.

39) Two (2) nos. Lime dosing Pumps with Piping, valves & instrumentation etc.

40) Four (4) nos. Alum Solution Preparation Tanks with motorized stirrer, flushing arrangement, instrumentation, valves, fittings and piping up to the Clarifiers.

41) Four (4) nos. Alum Dosing Pumps [4 nos. (3W + 1S) for PT-clarifiers of ACW system], [2 nos. (1W + 1S) for PT-clarifiers of DM system] & [2 nos. (1W + 1S) for Lamella Clarfiers] with Piping, valves & instrumentation etc.

42) Two (2) nos. Coagulant aid Preparation Tanks with motorized stirrer, flushing arrangement, instrumentation, valves, fittings and piping up to the all Clarifiers.

43) Two (2) nos. Coagulant aid dosing Pumps with Piping, valves & instrumentation etc for all the clarifiers.

44) Two (2) nos. Coagulant aid Preparation Tanks with motorized stirrer, flushing arrangement, instrumentation, valves, fittings and piping up to the Thickener & Centrifuge.

45) Two (2) nos. Coagulant aid dosing Pumps with Piping, valves & instrumentation etc for Thickener & Centrifuge.

46) Two (2) nos. PAC storage Tanks with flushing arrangement, instrumentation, valves, fittings and piping up to the all Clarifiers.

47) Two (2) nos. PAC unloading Pumps with Piping, valves & instrumentation etc for all the clarifiers.

48) Two (2) nos. PAC Preparation/dosing Tanks with motorized stirrer, flushing arrangement, instrumentation, valves, fittings and piping up to the all Clarifiers.

49) Two (2) nos. PAC dosing Pumps with Piping, valves & instrumentation etc for all the clarifiers.

50) One (1) No. Filtered Water Overhead Storage Tank (Civil Design & Construction is in BHEL Scope). The associated float type valve, overflow & drain arrangement, valves, instrumentation etc shall be in bidder's scope.

51) Two (2) nos. Weighing Scales, two (2) nos. electrically operated monorail hoist with trailing cable in chemical house common for both, Pretreatment plant & effluent treatment plant.

52) Two (2) nos. flushing pumps shall be provided by the bidder for flushing chemical and sludge lines including connection of all drains through a common header to stilling chamber/sludge sump.

53) Mandatory spares. .(Refer attached, Annexure-V/Section-C1).Bidder to consider all applicable spares, in case any spares is not applicable the relevant equivalent spares shall be provided by bidder within quoted price.

54) Start-up and commissioning spares as required.

55) All piping, valves, instruments as required for the system completion.

56) All motorized valves shall be provided with integral starter.

57) Operating platforms shall be provided for all the structures such as aerator, stilling chamber, clarifier, sludge chamber, thickener etc. along with ladders and hand railing.

58) All pipes ,puddle Pipes, fittings, structural steel etc. required for hand railing, platforms, and ladders shall be in the scope of bidder. All insert plates, nuts and bolts, counter flanges wherever applicable shall be in the scope of bidder.

59) Edge angle required in a proper shape for edge protection in civil works will be provided by bidder.

60) All sluice gates along with suitable protection shall be in the scope of bidder only.

61) All auxiliary steel structures (U-clamps, nuts, bolts, channels etc.) for fixing the pipe on the pedestal or trestles shall be in the scope of bidder.

62) .First fill/charge of all lubricants, grease, etc.

63) Wherever terminal points between BHEL and bidder indicated, bidder shall provide pipes with counter flange.

64) One set of all special tools & tackles of reputed make necessary for proper maintenance or adjustment of the equipment being supplied by the bidder, packed in permanent box.

65) Sufficient numbers of portable type ladders with plate form to be supplied for ease of maintenance.

66) Necessary pipe, piping, fitting, valves, drains, vents, sampling etc. required for the complete PT Plant. Pipe racks shall be provided by BHEL wherever available. Wherever pipe racks are not available, pipe shall be laid on pedestal. All auxiliary steel structure (U-clamps, nuts, bolts, channels etc.) for fixing pipes on pedestal or racks for complete pre-treatment plant shall be in bidder's scope.

67) All the sumps, tanks, reservoirs and other water retaining structures shall be provided with access ladders/ rungs from operating platforms/ ground level as the case may be and de-watering pits one for each section. Hand railing will be provided by bidder for safety purpose in all civil structures. Supply and erection of all Hand railing as desired for safety purpose will be in bidder's scope.

68) Charging platform for all the chemical tanks along with required handrails, accessories etc . Permanent ladder (not rungs) for approaching the top of tanks, valves for All steel inserts plates with lugs, plates, bolts, nuts, sleeves, edge angles and all other embedding components etc as required to grout in civil works and to support/hold the equipment's for opening/maintenance purpose, shall be in bidder's scope.

69) **Hand Railings and Ladders-**All handrails and ladders shall be galvanised at the rate of 610 Gms / Sq. as per IS : 4736.

70) All channels & brackets, mounting plates as required for mounting of motors, pumps, stirrers, tank etc.

71) Six (6) sets of safety equipment [(Personal Protection Equipment (PPE)] comprising PVC protection suits with hoods, rubber boots, face visors and thick PVC gauntlets shall also be provided by the bidder. Two (2) number safety shower units and adequate nos. of eye fountains to protect against any chemical hazard shall also be provided by the bidder.

72) All other things are also included in scope of supply as specified in other part of the specification including under design criteria and technical details.

73) Complete Civil as per specification and details indicated in Section C4 (Specific Technical requirement -Civil).

74) PIPING

All the piping as listed below shall be in bidder's scope. The below indicated pipes shall be designed, supplied, erected, laid and tested by the bidder. Elbows, tees, puddle pipes, flanges Hangers and supports, embedment plates with lugs etc required for the below given piping shall also be provided by the bidder.

a) All piping within the Pre-Treatment Plant.

b) Inlet and outlet pipes for each sumps, pits, pumps, other equipments, etc. with pipe connections to the respective sumps, pits, equipment.
c) Minimum 700 NB of 20 meter Raw water inlet piping to PT plant clarifiers as per Terminal point.

d) Minimum 600 meter potable water piping for colony up to the plant boundary as per Terminal point.

e) Service water piping, instrument air piping, service air piping, potable water piping, etc. as applicable as per the Terminal Points.

f) In addition, any additional piping and associated accessories required to complete the system shall be in bidder's scope.

4.0 SCOPE OF SUPPLY (ELECTRICAL)

Complete electrical as per specification and details indicated in Section C2 (Specific Technical requirement-Electrical).

5.0 SCOPE OF SUPPLY (C&I)

Complete C&I as per specification and details indicated in Section C3 (Specific Technical requirement -C&I).

6.0 SCOPE OF SUPPLY (CIVIL)

Complete Civil as per specification and details indicated in Section C4 (Specific Technical requirement -Civil).

7.0 SCOPE OF SERVICES

The bidder's scope also includes following services for scope under this specification:

1) Erection and commissioning, unloading, storage and handling at site.

2) Complete analysis, design, and construction, erection of all civil structural & architectural works of complete pretreatment plant area (Excluding Chemical house & Centrifuge Shed/Building).

3) Arrangement of all instruments, reagents, monitoring gadgets for monitoring, & lab facilities to carry out, pre-commissioning, trial run, commissioning, Performance guarantee test & till handover.

4) Monitoring gadgets, instruments and equipment required for maintenance.

5) Complete grouting for equipment, fixing and any concreting inside the vessels and lining.

6) All personnel required during maintenance, Commissioning and Performance guarantee test.

7) Trial run for requisite period.

8) Performance guarantee test.

9) Painting shall be as specified in "Surface Preparation & Painting" Sec-D1 of this technical specification. Bidder to note that paint shed shall be finalized during detailed engineering as per customer & BHEL requirement and any variation in the painting schedule as finally approved by customer shall be taken care by bidder without any commercial and delivery implication.

10) Final touch up paint at site.

11) Bidder shall perform the guarantee parameters as per specification requirement to the satisfaction of owner. The exact modalities of verifying guarantee for the parameters indicated in the specification shall be finally as agreed with the owner during detailed engineering & mutually agreed.

8.0 TERMINAL POINTS

1) PT Plant inlet-As per P&I diagram of Pre Treatment Plant.(Pressure at inlet of control valves shall be of 1.5 kg/cm2).

2) Filtered water to Colony & Plant- As per P&I diagram of Pre Treatment Plant.

3) Filtered water to DM plant- As per P&I diagram of Pre Treatment Plant.

4) 25 NB Instrument air supply at 5 to 7 kg/cm2 (g) – At 5 meter distance from PT Plant Chemical House. However distribution and piping inside PT Plant area shall be in bidder's scope.

5) 25 NB Service air supply at 5 to 7 kg/cm2 (g) - At 5 meter distance from PT Plant Chemical House. However distribution and piping inside PT Plant area shall be in bidder's scope. If service air required is more than provided by BHEL, bidder to provide necessary compressors/blowers and associated valves, piping, fittings, flanges, instruments etc. to meet the system requirement.

6) Service water connection (50 NB connections) at 5 meter distance from PT Plant Chemical House. Piping inside PT Plant area for mentioned services will be in bidder's scope.

7) Drinking water (or potable water) of 25 NB connections to PT Plant - At 5 meter distance from PT Plant Chemical House. However distribution and piping inside PT Plant area shall be in bidder's scope.

8) Potable water pipe to Plant shall be terminated at 5 meter from pump discharge. The pressure at Terminal Point will be 7 Kg/cm2 with respect to the elevation FGL.

9) Potable water pipe to colony shall be terminated near plant boundary (approximate co-ordinate 324821.96 E, 2615656.60 N). The pressure at Terminal Point will be 1 Kg/cm2 with respect to the elevation FGL.

10) Alum & Lime dosing line to effluent treatment plant of 50 NB (Min) for each chemical shall be terminated outside of chemical house at a distance of 5 m..

11) Filtered Water line from Overhead tank to Chlorine di oxide dosing plant of 50 NB (Min) at a distance of 5 m From outside of chemical house.

9.0 EXCLUSIONS

1) Civil Design & Construction work of Chemical House & Centrifuge Shed.

2) Dismantling or rerouting of any underground pipeline/ buried utilities.

3) All chemicals.

4) Air conditioning, ventilation & firefighting facilities. However, heat dissipation data for all motors & panels as applicable shall be finished by the bidder during detail engineering for sizing of HVAC equipment.

5) Other exclusions are mentioned in the electrical & C&I parts of this specification.

10.0 QP AND SUB VENDOR APPROVAL

1) The quality assurance plan is enclosed as Annexure-I/section-C1**.** However requirement of detailed QP, inspection checklist, certificate of conformance etc. for each equipment and sub-vendor shall be finalized during detailed engineering stage; decision of BHEL/customer shall be binding on vendor in this regard. Any changes/additional tests insisted upon by Owner during approval of QAP's shall be accepted by bidder without any commercial and delivery implication to BHEL/Customer. Bidder shall submit the quality plans in BHEL format during detailed engineering stage. Bidder to note further that during detailed engineering all the QAP's/check lists etc. shall be submitted to Customer/BHEL for approval. All inspection & testing etc. shall be carried out accordingly.

2) The sub vendor list enclosed as Annexure-II/section-C1 is indicative only and is subject to approval / acceptance by customer (NTPC). Bidder to propose his sub vendor list with back up documents (experience list, end user certificate as applicable) etc. The same shall subject to BHEL and Customer approval during detailed engineering stage without any technical, commercial & delivery implication to BHEL.

11.0 PERFORMANCE GUARANTEE TEST

The Performance guarantee test shall be as per Annexure-III/Section-C1A.

12.0 DESIGN CRITERIA AND TECHNICAL DETAILS

In addition to the requirements of Section C & D the following shall also be complied under scope of this specification.

The P&ID for Pre Treatment Plant (**Dwg.No.- PE-DG-434-158-A001**) is enclosed herein in this section for bidders compliance.

The material of construction specified in data sheet-A are minimum requirements and material of construction for other components not specified shall be similarly selected by the bidder for intended duty which shall be subject to BHEL / Customer approval during detail engineering without any commercial & delivery implication to BHEL.

The other technical requirement shall be as per Technical Requirement of water treatment system. Please refer Section-D1 of this specification.

13.0 DRAWING/DOCUMENTS REQUIREMENT

For the Drawings/Documents Requirement & Distribution submission schedule, please refer **Annexure-IV/Section-C1.**

The bidder has to submit the revised drawing/document along with the compliance sheet indicating enumerate reply to all BHEL and customer comments or observations. Without compliance sheet the submission of the drawings/documents will not be considered and the delay on this account will be solely on bidder's side only. Bidder to comply with the observations of the BHEL and CUSTOMER without price & delivery implication.

14.0 ADDITIONAL REQUIREMENT

1. Engineering for this project is to be carried out in Integrated Intelligent Engineering environment at BHEL end. For Details Refer Drawings/Documents Requirement & Distribution submission schedule

2. Initial charge of all lubricants & grease.

3. All special tools necessary for proper maintenance or adjustment of the equipment packaged in permanent box. Finish paints for touch-up painting of equipment after erection at site in sealed container.

4. Wherever pipe racks are not available, pipes shall run on pedestals or below ground. All fixing items such as U clamps, nuts, bolts etc. required to lay the pipes on pedestals shall be in bidder's scope of work. Coating, wrapping and protection required for buries pipes shall be in bidder's scope of work.

5. Wherever pipes are running on pipe rack ,Bidder will consider 12 m static head + 10% margin ,in addition to the losses in straight length and bend in pipes and valves etc. while selection of pump head during detailed engineering.

6. The pumps shall be designed to operate under discharge valve open and close condition.

7. Pump suction valves, re-circulation valves and discharge valves shall be provided with required limit switches for interlock & control.

8. The starting of pumps (wherever applicable) which are provided with forced water lubrication shall be interlocked with the availability of lube water by means of starting of lubrication water pumps, availability of adequate flow, pressure etc. The standby lubrication pump shall be started automatically during inadequate pressure or while tripping of working pump(s).

9. All the first fill and one Year's topping requirements or 10 % of first fill quantity, whichever is more of consumable such as greases, oil, lubricants, servo fluids/control fluids, gases and etc. which will be required to put the equipment covered under the scope of specifications, into successful commissioning / initial operation and to establish completion of facilities shall be furnished by the bidder. Suitable standard lubricants as available in India are desired. Efforts should be made to limit the variety of lubricants to minimum.

10. Document approval by customer under Approval category or information category shall not absolve the vendor of their contractual obligations of completing the work as per specification requirement. Any deviation from specified requirement shall be reported by the vendor in writing and require written approval. Unless any change in specified requirement has been brought out by the vendor during detail engineering in writing while submitting the document to customer for approval, approved document (with implicit deviation) will not be cited as a reason for not following the specification requirement.

11. In case vendor submits revised drawing after approval of the corresponding drawing, any delay in approval of revised drawing shall be to vendor's account and shall not be used as a reason for extension in contract completion.

12. Bidders shall make Site visit in order to familiarize themselves with existing condition of site before submitting the bid in order to make their offer complete. During detail engineering also, the successful bidder shall be responsible for the correctness of details w.r.t. existing facility at site. Customer approval on any drawing having details of existing facility shall not be cited by the successful bidder a valid reason for any shortcoming in the work by them. BHEL shall also not entertain any cost implication for any lack of input data with regard to site during detail engineering.

13. Final Electrical Load list will be submitted by the successful bidder as per agreed drawing/ doc submission schedule. Thereafter any change in the electrical load list shall be entertained only subject to its feasibility, and BHEL reserves the right to debit the vendor cost of any changes necessitated in the switch gear /MCC on account of changed loads.

14. The complete system shall be proven and necessary design documentation in support of proveness shall be submitted by the successful bidder in support of the systems, if asked by the customer without any price and delivery implication to BHEL and customer.

15. For chemical house & centrifuge shade/building, successful bidder shall furnish civil assignment / scope drawings. The corresponding CIVIL drawing prepared by BHEL / CIVIL agency, based on civil assignment drawing of bidder will be furnished to the site for construction. In case any modification is required in the civil work already carried out based on final civil inputs given by vendor, BHEL reserves the right to debit cost of such rework to vendor".

16. System to be designed to meet all the statutory requirements. Preparation of all necessary drawings/data/ documents for obtaining necessary Approval of statutory authorities like CCOE , IBR , Weight & Measures Department and any other agency/ competent authority ,on behalf of the customer, related to installation of PT plant (if required) is included in bidder's scope. All expenses required to obtain the approval shall also be borne by the successful bidder. Successful bidder shall inform customer well in advance requirement of authority letter along with format for the same. After issuance of authority letter by customer, it will be vendor's responsibility to regularly follow up with the concerned authorities to obtain timely approval from these authorities. Any delay on account of the same, unless any specific information related to above approval to be furnished by customer is delayed by customer, shall be to vendor's account and shall not be used as a reason for extension in contract completion.

17. Vendor to attend regular engineering meeting with BHEL and customer fortnightly in BHEL or customer office as decided during detail engineering. Vendor will depute all his concerned engineering representative along with the project manager for discussion and approval. Meeting can be held at site also.

18. Space available for PT Plant is attached, elsewhere in this specification. Bidder to accommodate their equipment within the space provided.

19. Bidder to submit BBU during detailed engineering after approval of Basic documents. Incomplete BBU shall not be reviewed by BHEL.

20. Preparation of drawings / document / P&ID's in 3D modelling software and providing soft copy of same to BHEL.

21. Preparation of e-learning package/module and providing the same to BHEL & NTPC for the complete pre-treatment plant. The necessary requirement shall be as per detail specified elsewhere in this specification.

22. Training of plant Owner's personnel, O&M operators' personnel on plant operation and maintenance.

23. Any statutory requirement / clearance required for the packages from government / local body shall be in bidder's scope. Any change arising out of any new government norms, statutory requirements during the course of execution of the project shall also be complied by the bidder without any commercial implication.

24. Instrument, valves, & piping shown in the flow diagram/ P&IDs are bare minimum requirement. Any additional instrument, valves, and piping required as per system requirement, shall be in the bidders scope.

25. Wherever gravity flow is not possible the bidder shall provide suitable storage & pumping system (2x100%) along with Piping, valves & instrumentation etc to meet the system & process requirement.

26. Service water shall be available near to pretreatment plant/ system building/ area at approximately 1.5 to 2.0 Kg/ Cm2. Hence, bidder to take care for cooling/ lubrication of the pumps being supplied by the bidder under this technical specification. If service water pressure requirement is more than available pressure, bidder to consider two (2) nos. cooling pump/lubrication pump for pre-treatment plant.

27. Capacity of monorail hoists, chain pulley block wherever indicated in Datasheet– A are minimum and capacity of such hoists, chain pulley block etc. shall be suitable for handling 125% of maximum weight to be handled during erection and maintenance of the equipments in the pump house, buildings etc. as the case may be.

28. Wherever local instruments for measurement of Flow, Pressure, Level is indicated in the P&ID, Bidder to provide Diaphragm seal type instrument for Chemical (all type and concentration), corrosive, viscous fluids application.

29. Slings & Lifting lugs shall be provided in all equipment.

30. In case of any conflict and repetition of clauses in the specification, the more stringent requirements among them are to be complied with.

31. Latest version of all codes and standards to be followed.

15.0 SITE VISIT BEFORE SUBMISSION OF OFFER.

Bidders shall make Site visit in order to familiarize themselves with existing condition of site before submitting the bid in order to make their offer complete. During detail engineering also, the successful bidder shall be responsible for the correctness of details w.r.t existing facility at site. Customer approval on any drawing having details of existing facility shall not be cited by the successful bidder a valid reason for any shortcoming in the work by them. BHEL shall also not entertain any cost implication for any lack of input data with regard to site during detail engineering.

ANNEXURE – I

Test/Check / Items / Components	Material Test	WPS/PQR/Welder	DPT/MPI	Assembly Fit up	Dimension	RT	Hydraulic test / Pneumatic test / Vacuum test	Performance Test	Test as per relevant Std / Appd. Data Sheets	Other Tests	Remarks
COMMON ITEMS:											
1. Horizontal Centrifugal Pumps				Y	Y			Y^1	Y		
1.1. Casing	Y^a		Y^b		Y		Y				
1.2. Impeller	Y^a		Y^b		Y					Y^d	
1.3. Shaft	Y^a		Y		Y					Y^c	
2. Vertical Pumps				Y	Y			Y^1	Y		
2.1. Casing	Y^a		Y^b		Y		Y				
2.2. Impeller	Y^a		Y^b		Y					Y^d	
2.3. Shaft	Y^a		Y		Y					Y^c	
2.4. Fabricated Parts	Y^a	Y	Y^b		Y	Y^2	Y				
3. Dosing/ Metering Pumps	Y^a				Y		Y	Y^1	Y		
4. Gate/ Globe/ Check Valves	Y^a		Y^b		Y		Y	Y	Y	Y^3, Y^6	
5. Dual Plate Check Valves	Y^a		Y^b		Y		Y	Y	Y	Y^6, Y^{12}	
6. Diaphragm Valves	Y^a				Y		Y		Y	Y^4, Y^3	
7. Butterfly Valves (Low Pr.)				Y	Y		Y	Y	Y	Y^3	

LEGENDS: Applicable tests are identified by 'Y'.

Y^a : One per Heat / Heat Treatment batch / Lot.

Y^b : On machined surfaces only. Also 100% on Butt Welds & 10% on Fillet Welds.

Y^c : UT shall be done for shafts with Dia 50 mm or above & Plates of Thickness 25 mm or above.

Y^d :Dynamic Balancing per ISO: 1940, Grade 6.3 minimum shall be conducted for rotating assy.

Y^1 : As per Pump governing standard. Tolerences as per HIS, USA.

Y^2 : Random 10% RT to be conducted on butt welds for Thk $\geq$10 mm.

Y^3 : Seat Leakage Test for actuator operated valves shall be done by operating the valve with job actuator.

Y^4 : Tests on Rubber Diaphragms shall be conducted per batch of Rubber mix for Tensile, Elongation, Hardness, Thickness, Bleed Resistance. In addition, Type Test for 50,000 cycles for each type of diaphragm shall also be conducted.

7.1 Body & Disc (Cast	Y^a		Y^b		Y						Y^6 : Blue Matching, Wear Travel for Gate Valves and reduced pressure test for check valves shall be conducted as per relevant standards. Y^7 : Heat Treatment of the Tank/Vessel shall be done per fabrication code requirement. Welded dished ends shall be stress relieved. Dished ends manufactured by cold working shall also be stress relieved as per the requirement of code. Y^8 : RT as per fabrication code requirements. However, dished ends welds, if manufactured by using welded plates shall be subjected to 100% RT. Y^9 :Rubber Lining Mix shall be subjected to Bleed Resistance Test on mould sample. Adhesion Test, Spark Test and Hardness Test for the Rubber lined jobs shall also be conducted. Y^{10} :Gear Boxes shall be checked for smooth No Load Operation at shop to verify noise and vibration levels. Gear Ratio and Kerosene Leak Test shall also be conducted. Y^{11} :One Fan of each type & size shall be routine performance tested as per corresponding code for air flow, static pressure, total pressure, speed, efficiency, power consumption, noise & temperature rise. Also all Fans shall be subjected to run test of 4 hours during which noise, vibration, temperature rise and current drawn shall be measured. Y^{12} :Dry cycle test on valve spring for 1, 00,000 cycles shall be carried out as type test, if not carried out earlier, for the similar MOC, size and type of spring. Y^{13}: :Test as per approved supplier practice. Y^{14} : Electronic leak test for condenser & evaporator unit. Note: The complete Piping system along with valves & fittings shall be hydraulically tested at 1.5 times design pressure or 2 times working pressure whichever is higher after erection at site.

Test/Check / Items / Components	Material Test	WPS/PQR/Welder	DPT/MPI	Assembly Fit up	Dimension	RT	Hydraulic test / Pneumatic test / Vacuum test	Performance Test	Test as per relevant Std / Appd. Data Sheets	Other Tests	Remarks
7.2 Body and Disc (Fabricated)	Y[a]	Y	Y[b]		Y				Y	Y[2]	
7.3 Shaft	Y[a]		Y[b]		Y					Y[c]	
8. Plug/ Ball Valves (Low Pr.)	Y[a]		Y[b]	Y	Y		Y	Y	Y	Y[3]	
9. Blowers/ Compressors	Y[a]		Y[b]	Y	Y			Y	Y	Y[c], Y[d]	
10. Tanks/ Pressure Vessels	Y[a]	Y	Y[b]	Y	Y	Y[8]	Y		Y	Y[7]	
11. Rubber Lining	Y[a]				Y				Y	Y[9]	
12. Strainers	Y[a]	Y	Y[b]	Y	Y		Y		Y		
13. Pipe & Pipe Fittings	Y[a]	Y	Y		Y	Y[8]	Y		Y		
14. Agitators /Flash Mixer/ Flocculator	Y[a]	Y	Y[b]	Y	Y			Y		Y[10]	
15. Ventilation/Exhaust Fan	Y[a]		Y[b]	Y	Y			Y[11]	Y	Y[c], Y[d]	
16. Hoists & Cranes	Y[a]	Y	Y[b]	Y	Y	Y[8]		Y	Y		
17. Wrapping & Coatig Material	Y				Y				Y		
18. Package/ Split AC	Y							Y	Y	Y[14]	

Test/Check / Items / Components	Material Test	WPS/PQR/Welder	DPT/MPI	Assembly Fit up	Dimension	RT	Hydraulic test / Pneumatic test / Vacuum test	Performance Test	Test as per relevant Std / Appd. Data Sheets	Other Tests	Remarks
PT & LET PLANT:											
1. Clariflocculator / Reactor Clarifier / Plate or Tube Settler	Y[a]	Y	Y[b]	Y	Y				Y	Y[10]	
2. Chlorine Tonner / Chlorine Evaporator	Y[a]	Y	Y[b]	Y	Y	Y[8]	Y		Y		
3. Chlorinator / Ejector	Y[a]			Y	Y		Y	Y	Y		
4. Chlorine Gas Filter	Y[a]			Y	Y		Y		Y		
5. Pressure / Vacuum Relief valve / Pressure Regulating Valve	Y[a]			Y	Y		Y	Y	Y		
DM PLANT & CWT SYSTEM:											
1. Resins / Activated Carbon									Y		
2. Filter Membrane					Y				Y		
3. RO Pressure tube	Y[a]				Y		Y		Y		
CPU SYSTEM:											
1. Butterfly valves / Ball valves (HP)	Y[a]			Y	Y		Y	Y	Y	Y[3]	
2. Resins / Activated Carbon									Y		

1) The above mentioned requirement are bare minimum. However any additional comments provided by BHEL / Customer shall be adhered by successful bidder without any commercial and delivery implication to BHEL/Customer.

QAP FOR LOW PRESSURE PIPING (LP PIPING)

PIPES, FITTINGS, BENDS, VALVES, COATING-WRAPPING, STRAINERS EXPANSION, JOINTS, TANKS, FASTENERS, LINING ETC.

	Tests/Check / Items / Components	Material Test	DPT/MPI / RT	Ultrasonic Test	WPS/ WQS/PQR	Hydraulic / Water Fill Test	Pneumatic Test	Assembly Fit up	Dimensions	Functional/operational Test	Other Tests	All Tests as per relevant Std	REMARKS
1	Pipes & Pipe Fittings	Y[a]	Y[b]			Y1			Y			Y	
2	Diaphragm Valves	Y[a]				Y[5]			Y		Y[6]		
3A	Cast Butterfly Valves (Low Pressure)					Y		Y	Y	Y	Y[7]		
	Body	Y[a]	Y[b]										
	Disc	Y[a]	Y[b]										
	Shaft	Y[a]	Y	Y[c]									
3B	Fabricated Butterfly Valves	REFER NOTE 14											
4	Gate/ Globe/Swing Check / Ball Valves	Y[a]	Y[b]	Y[c]		Y[5]	Y	Y	Y	Y	Y[8]		
5	Dual Plate Check Valves	Y[a]	Y[b]	Y[c]		Y	Y	Y	Y	Y	Y[4]		
6	Rolled & Welded Pipes and Mitre Bends	Y[a]	Y[3]		Y	Y[3]			Y		Y[3] &15	Y	
7	Coating & Wrapping of Pipes	Y[2]									Y[2]		
8	Tanks & Vessels	Y[a]	Y[b]		Y	Y			Y		Y[16]		
9	Strainers	Y[a]	Y[b]		Y#	Y					Y[11]		#For Fabricated Strainer
10	Rubber Expansion Joints	Y[a]				Y[12]		Y	Y		Y[13]		
11	Internal Lining of Pipes	Y[a]							Y		Y[9]		
12	Site Welding		Y[10]		Y	Y							

	NOTES (MEANING OF SUPERSCRIPTS)
a	One per heat/heat treatment batch/lot.
b	On machined surfaces only for castings and on butt welds.
c	For shaft/spindles > or = 50 mm
1	100% Hydraulic test shall be carried out. Weld joints not subjected to hydraulic test shall be subjected to 100% RT
2	Spark Test, Adhesion Test and Material Test for primer and enameled & Coal Tar Tapes as per AWWA-C-203-91/ IS-10221/IS 15337 as applicable.
3	Followings are the testing requirements for fabrication of pipes at site

TESTS	QUANTUM OF CHECKS
WPS, PQR, Welder Qualification Test	100%
DPT on root run	100% for pipes up to 1200 mm diameter

	DPT after back gauging	100% for pipes above 1200 mm diameter
	RT / UT by TIME OF FLIGHT DEFRACTION (TOFD) Technique	5% (100% of T Joints)
	DPT on finished butt weld joints	10%
	Hydraulic Test	100%, 1.5 times the design pressure or 2 times the working-pressure whichever is higher.
4	Dry Cycle Test on Dual Plate Check valve spring for one lakh Cycles shall be carried out as a type test. If Dry Cycle test carried out earlier for same material & diameter, Test report shall be reviewed.	
5	Seat Leakage Test for Actuator Operated Valves, shall be done with by closing the valves with actuator.	
6	Tests on rubber parts shall be conducted per batch of rubber mix for tensile, Elongation, hardness, adhesion, spark test, bleed resistance test. In addition, type test for 50,000 cycles of each type of diaphragm shall also be conducted.	
7	Hydraulic Test of Body, Seat and disc-strength shall be carried out in accordance with governing design standard in presence of owner's representatives. Actuator operated valves shall be checked for Seat Leakage by closing the valves with actuator. For Proof of Design Test refer respective chapters of engineering portion in the technical specification	
8	Blue matching, wear travel for gates, valves, pneumatic seat leakage, and reduced pressure test for check valves shall be done as per relevant standard. Maximum allowable vacuum loss is 0.5 mm of Hg abs. for valves to be tested for vacuum operation for internal pressure 25 mm of Hg abs. for a period of 15 minutes. Fire safe test for ball valve shall be done wherever specified. In case of already carried out, the test report shall be submitted for review and acceptance by NTPC Engineering. Valves shall be offered for hydro test in unpainted condition.	
9	Tensile, Elongation, Hardness, Specific Gravity, Lining Thickness, Humidity Check, Pipe temperature check, Adhesion Test and Holiday Detection Test etc as per applicable standard shall be done for all lining material and application.	
10	10% of welds (Root and finished welds) shall be subjected to DPT.(100% DPT for compressed air line and boiler & deaerator fill line.).	
11	Pressure drop across the strainer for each type and size as a special test shall be carried out. In case of already carried out, the test report shall be submitted for review and acceptance by NTPC Engineering.	
12	During hydraulic and vacuum tests at 25mm Hg abs in 3 positions, the change in the circumference of arch should not be more than 1.5%. 24 hrs after the test permanent set in dimension should not exceed 0.5%.	
13	Tests on rubber for tensile, elongation, hardness, hydraulic stability check as per ASTM D 471, ozone resistance test as per ASTM D 1149 aging test and adhesion strength of rubber to fabric, rubber to metal adhesion shall be carried out.	
14	In addition of all tests as indicated for Cast Butter Fly valve being applicable for fabricated butterfly valves, following test shall be done for Fabricated Butter Fly Valve: a. UT as per ASTM A-435 on plate material for body and disc shall be carried out for plate thickness 25mm and above. b. 100% RT and DPT as per ASTM, Section-VIII, Division-I, on butt joins of body and disc. 10% DPT on other welds shall be done. c. Post weld heat treatment as per ASME, Section-VIII, Division-I on butt joints of body and disc. d. Welders and WPS shall be qualified as per ASME- section IX	
15	Maximum number of segments in segmental flanges shall be four (04) only. All butt weld joints in the segmental flanges shall be examined by RT/UT. Segmental flanges exceeding 37.5 mm thickness shall be stress-relieved as per norms of ASME Section VIII after welding	
16	For pressure vessel welds RT shall be done as per design code requirements.	

QAP FOR EOT CRANES AND HOISTS

Shop Test for EOT Cranes, Other Cranes & Hoist

1.0 HOOKS

1.01 ALL TESTS INCLUDING PROOF LOAD TEST AS PER RELEVANT IS/BS/DIN SHALL BE CARRIED OUT.

1.02 MPI/DPT SHALL BE CARRIED OUT AFTER PROOF LOAD TEST.

2.0 STEEL CASTING

2.01 DPT ON MACHINED SURFACE SHALL BE CARRIED OUT.

3.0 GIRDERS, END CARRIAGE,CRAB, GEAR BOX AND ROPE DRUM

3.01 THE PLATES OF THICKNESS 25MM AND ABOVE SHALL BE ULTRASONICALLY TESTED.

3.02 NDT REQUIREMENTS ON WELDMENTS SHALL BE AS FOLLOWS:

a) BUTT WELDS IN TENSION:- 100% RT AND 100% DPT
b) BUTT WELDS IN COMPRESSION:- 10% RT AND 100% DPT
c) BUTT WELDS IN ROPE DRUM:- 100% RT AND 100% DPT
d) FILLET WELDS:- RANDOM 10% DPT

4.0 FORGING (WHEEL, GEARS, PINIONS, AXLE, HOOKS & HOOK TRUNION)

4.01 ALL FORGINGS GREATER THAN OR EQUAL TO 50 MM DIAMETER OR THICKNESS SHALL BE SUBJECTED TO ULTRASONIC TESTING.

4.02 DPT/MPI SHALL BE DONE AFTER HARDFACING AND MACHINING.

5.0 WIRE ROPE SHALL BE TESTED AS PER RELEVANT STANDARD.

6.0 REDUCTION GEARS SHALL BE TESTED FOR REDUCTION RATIO, BACKLASH & CONTACT PATTERN. GEAR BOX SHALL BE SUBJECTED TO NO-LOAD RUN TEST TO CHECK FOR OIL LEAKAGE, TEMPERATURE RISE, NOISE AND VIBRATION.

7.0 THE CRANES SHALL BE COMPLETELY ASSEMBLED AT SHOP FOR FINAL TESTING. ALL TESTS FOR DIMENSION, DEFLECTION, LOAD, OVERLOAD, HOISTING MOTION, CROSS TRAVEL ETC. AS PER IS-3177 SHALL BE CARRIED OUT AT SHOP.

8.0 ALL ELECTRIC HOISTS SHALL BE TESTED AS PER IS-3938 AND CHAIN PULLEY BLOCKS SHALL BE TESTED AS PER IS-3832.

9.0 LIFTING BEAM:

9.01 THE PLATES OF THICKNESS 25MM AND ABOVE SHALL BE ULTRASONICALLY TESTED.

9.02 NDT REQUIREMENTS ON WELDMENTS SHALL BE AS FOLLOWS:

a) BUTT WELDS IN TENSION:- 100% RT AND 100% DPT
b) BUTT WELDS IN COMPRESSION:- 10% RT AND 100% DPT
c) FILLET WELDS:- RANDOM 10% DPT

9.03 ALL FORGINGS GREATER THAN OR EQUAL TO 50 MM DIAMETER OR THICKNESS SHALL BE SUBJECTED TO ULTRASONIC TESTING.

9.04 DPT/MPI SHALL BE DONE AFTER MACHINING.

9.05 Lifting Beam will be subjected to overload testing at @1.25 X SWL of Lifting Beam at manufacturer works.

ANNEXURE-II

SUB-VENDOR LIST

	Project:	PATRATU	3x800	MW	LIST OF ITEMS REQUIRING QUALITY PLAN			DOC. NO.:	CS-9585-001-2	
					AND SUB-SUPPLIER APPROVAL			REV. NO. :		
	Package:	EPC						DATE:	06.04.2017	
	Supplier:	BHEL								
	Contract No.:	CS-9585-001-2			SUB-SYS	STEAM GENERATOR/RAW MATERIALS				
S.No.	ITEM	QP/Insp. Cat.	QP No.	QP Sub-Schedule	QP approval schedule	Proposed sub-supplier	Place	Suppliers approval status/ category	supplier Details submission schedule	Remarks
1	SEAMLESS TUBES	$				TUBOS REUNIDOS	SPAIN	A		CS,T-11,T-12,22,T-23,T-91
		$				VALLOREC & MANNESMANN	GERMANY	A		T-92,T-91,T-23,T-22,T-11,T-12,CS
		$				VALLOREC TUBES	FRANCE	A		T-92,T-91,T-23,T-22,T-11,T-12,CS
		$				TENNARIS GLOBAL(NKK TUBES)	JAPAN	A		T-91,T-22,T-11,T-12,CS
		$				HENGYANG VALIN STEEL TUBE CO.	CHINA	A		CS & AS UPTO T-22(with TPI INSPECTION) SUB TO CONDITIONS
		$				TENNARIS GLOBAL(DALMIN ITALY)	ITALY	A		T-22,T-11,T-12,CS
		$				JINAGSU CHENGDE STEEL TUBE	CHINA	A		T-92,T-91,T-22,T-11,T-12,CS SUB TO TPIA INSPECTION CONDITIONS
		$				JEE(KAWASAKI)	JAPAN	A		T-92,T-91,T-22,T-11,T-12,CS
		$				TENNARIS GLOBAL(SILCO, ROMANIA)	ROMANIA	A		CS,T-11,T-22,T-23,T-91,T-12,
		$				CHANGZHOU CHANGBAO PRECISION	CHINA	A		CS
		$				PRODUCTUS TUBLARES	SPAIN	A		T-91,T-22,T-11,T-12,CS
		$				SUMITOMO METALS	JAPAN	A		T-92,T-91,T-23,T-22,T-11,T-12,CS
		$				BENTLER	GERMANY	A		T-92,T-91,T-22,T-11,T-12,CS,SS
		$				IBF	ITALY	A		T-91,T-22,T-11,T-12,CS
		$				WAYMAN GORDAN	USA	A		T-91,T-22,T-11,T-12,CS,
		$				BHEL SSTP	TRICHY	A		T-22,T-11,T-12,CS
		$				JINDAL SAW LTD.	NASHIK	A		CS,T-11,T-22 ,T-12,SUB TO CONDITIONS
		$				REMI	INDIA	A		CS,T-11,T-22 ,T-12,SUB TO CONDITIONS
		$				ISMT	AHMEDANAGAR/BARAMATI	A		CS,T-11,T-22 ,T-12,SUB TO CONDITIONS
		$				MSL	RAJGAD	A		CS SUB TO CONDITIONS
		$				BAOSHAN IRON & STEEL CO. LTD.	CHINA	A		CS,T-11,T-22,T-12,(WITH TP1) SUBJECT TO CONDITIONS

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06-04-2017
A. SAKTHI GANESH
Engineer - QA/BHEL-Trichy

Annexure-Q1

	Project:	PATRATU	3x800	MW	LIST OF ITEMS REQUIRING QUALITY PLAN			DOC. NO. :	CS-9585-001-2	
					AND SUB-SUPPLIER APPROVAL			REV. NO. :		
	Package:	EPC						DATE:	06.04.2017	
	Supplier:	BHEL								
	Contract No.:	CS-9585-001-2			SUB-SYS	STEAM GENERATOR/RAW MATERIALS				
S.No.	ITEM	QP/Insp. Cat.	QP No.	QP Sub-Schedule	QP approval schedule	Proposed sub-supplier	Place	Suppliers approval status/ category	supplier Details submission schedule	Remarks
		$				HMT	GUJARAT	A		HOT FINISHED CS GRADE (UPTO 76.2 MM OD & 12 MM THK)
		$				CHANGZHOU CHANGBAO PRECISION	CHINA	A		T-11,12
2	SEAMLESS TUBES(RIFLED)	$				SALZGITTER MANESS/AMANN PRECISION	FRANCE	A		CS
		$				CHANGHOU CHANGBAO PRECISION	CHINA	A		T-11,12
		$				BAOSHAN STEEL	CHINA	DR		
		$				TENNARIS GLOBAL(DALMINE)	ITALY	DR		
		$				SUMITOMO	JAPAN	DR		
		$				TUBOS REUNIDOS	SPAIN	DR		
3	SEAMLESS TUBES(SS)	$				KOBE	JAPAN	A		SS 304,SS347H
		$				POSCO SPL STEEL CO	KOREA	A		SS 304,347H,SUPER 304
		$				TUBACEX	SPAIN	A		
		$				SMST	ITALY	A		SS 304,347H, SUPER 304
	SEAMLESS TUBES(SS)UPTO DIA<76.1MM	$				SUMITOMO METAL IND LTD.	JAPAN	A		SS 304,347H, SUPER 304
	SEAMLESS TUBES(SS) UPTO OD 159.0MM & WT-12.5MM	$				HUADI STEEL GROUP	CHINA	A		SS 304, 304H,347H(WITH TPI) SUB TO CONDITIONS
	SEAMLESS TUBES(SS) UPTO OD 159.0MM & WT-12.5MM	$				ZHEJIANG JIULI HI TECH	CHINA	A		SS 304, 304H,347H(WITH TPI) SUB TO CONDITIONS
						PRODUCTUS TUBLARES	SPAIN	DR		
4	SEAMLESS PIPES	$				TUBACEX	SPAIN	A		SS PIPES
		$				SUMITOMO METALS	JAPAN	A		P-92,P-91,P-22,P-11,P-12,CS
		$				VALLOREC TUBES	FRANCE	A		P-92,P-91,P-22,P-11,P-12,CS

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Patratu Vidyut Utpadan Nigam Limited (Jharkhand) * C&M Deptt. *

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	Project:	PATRATU	3x800	MW	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB-SUPPLIER APPROVAL			DOC. NO.:	CS-9585-001-2	
								REV. NO. :		
	Package:	EPC						DATE:	06.04.2017	
	Supplier:	BHEL								
	Contract No.:	CS-9585-001-2			SUB-SYS	STEAM GENERATOR/RAW MATERIALS				

S.No.	ITEM	QP/Insp. Cat.	QP No.	QP Sub-Schedule	QP approval schedule	Proposed sub-supplier	Place	Suppliers approval status/ category	supplier Details submission schedule	Remarks
		$				HENGYANG VALIN STEEL TUBE COL	CHINA	A		CS
		$				BHEL SSTP	TRICHY	A		CS
		$				TUBOS REUNIDOS	SPAIN	A		P-91,P-22,P-11,P-12,CS
		$				VALCONVY TRUB	CZECH REP	A		CS,P-11,P-12,P-22
		$				ACELOR MITTAL	ROMANIA	A		CS
		$				WAYMAN GORDAN	USA	A		P-91,P-22,P-11,P-12,CS
		$				TENNARIS GLOBAL(NKK TUBES)	JAPAN	A		P-91,P-22,P-11,P-12,CS
		$				IBF SPA	ITALY	A		P-92,P-91,P-22,P-11P-12,CS
		$				JFE(KAWASAKI)	JAPAN	A		P-92,P-91,P-22,P-11,P-12,CS
		$				PRODUCTUS TUBLARES	SPAIN	A		P-91,P-22,P-11P-12,CS
		$				VALLOREC & MANNESMANN	GERMANY	A		P-92,P-91,P-22,P-11,P-12,CS
		$				TENNARIS GLOBAL(DALMINE)	ITALY	A		P-91,P-22,P-11,P-12,CS
		$				JINDAL SAW LTD.	NASHIK	A		CS,P-11,P-22 ,P-12,SUB TO CONDITIONS
		$				ISMT	AHMEDANAGAR/BARAMATI	A		CS,P-11,P-22,P-12, SUB TO CONDITIONS
		$				YANGZHOU CHENGDE STEEL PIPE CO. LTD.	CHINA	A		P-92,P-91,P-22,P-11,P-12,CS SUB TO TPIA INSPECTION CONDITIONS
		$				MSL	RAJGAD	A		CS SUB TO CONDITIONS
		$				REMI	BHARUCH	A		CS,P-11,P-22 ,P-12,SUB TO CONDITIONS
		$				RATNAMANI	MUMBAI	DR		CS
		$				ZIZIANG GROSS	CHINA	DR		CS
		$				PRODUCTUS TUBLARES	SPAIN	DR		FOR P92 GRADE
	SEAMLESS PIPES(DIA UPTO 159MM)	$				TENNARIS GLOBAL SILCO TUBES)	ROMANIA	A		P-91,P-22,P-11,P-12,CS
	SEAMLESS PIPES(UPTO 160MM)	$				BENTLER	GERMANY	A		P-92,P-91,P-22,P-11,P-12,CS
	SEAMLESS PIPES(UPTO 219.0MM)	$				JIANGSU CHENGDE STEEL TUBE	CHINA	A		P-92,P-91,P-22,P-11,P-12,CS SUB TO TPIA INSPECTION CONDITIONS

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Patratu Vidyut Utpadan Nigam Limited * (Jharkhand) * C & M Deptt.

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	Project:	PATRATU	3x800	MW	LIST OF ITEMS REQUIRING QUALITY PLAN			DOC. NO. :	CS-9585-001-2	
					AND SUB-SUPPLIER APPROVAL			REV. NO. :		
	Package:	EPC						DATE:	06.04.2017	
	Supplier:	BHEL								
	Contract No.:	CS-9585-001-2			SUB-SYS	STEAM GENERATOR/RAW MATERIALS				
S.No.	ITEM	QP/Insp. Cat.	QP No.	QP Sub-Schedule	QP approval schedule	Proposed sub-supplier	Place	Suppliers approval status/ category	supplier Details submissio n schedule	Remarks
	SEAMLESS PIPES(UPTO 88.9MM)	$				BAOSHAN IRON & STEEL CO. LTD.	CHINA	A		CS SUBJECT TO CONDITION
	SEAMLESS PIPES(UPTO OD 914 X WT 102 MM)	$				RINGMIL	ITALY	A		FORGED CS PIPE
5	PLATES & ROLLED SECTION(UPTO GRADE 91)	$				INDUS STEEL	BELGIUM	A		CS-SA515 AS UP T0 GR-91
		$				ILSENBURGER GROBBLECH(SALZGITTER MANESSMANN)	GERMANY	A		CS-SA 299, SA515, BS EN 10025, IS 2062 OTHER STRUCTURAL STEEL GRADES; AS UPTO GR.-91
		$				DILLINGER-GTSVENTES	GERMANY	A		CS-SA 299, SA515, BS EN 10025, A36, IS 2062 OTHER STRUCTURAL STEEL GRADES; AS UPTO GR.-91
		$				ARCONI D.O.O.	SLOVENIA	A		CS- SA515, BS EN 10025, A36, IS 2062 OTHER STRUCTURAL STEEL GRADES; AS UPTO GR.-91
6	PLATES & ROLLED SECTION(UPTO GRADE 22)	$				THYSEEN KRUPP	GERMANY	A		CS- SA515 BS EN 10025 A36 IS 2062 OTHER STRUCTURAL STEEL GRADES. AS UPTO GR.-22
		$				INDUSTEEL LOIRE	FRANCE	A		CS-SA 299, SA515; AS UPTO GR.-22
		$				ESSAR STEEL LTD.	HAZIRA	A		CS- SA515, BS EN 10025, A36, IS 2062, OTHER STRUCTURAL STEEL GRADES; AS GR.-12 &22
		$				VOESTALPINE GROBBLECH GMBH	AUSTRIA	A		CS- SA515 BS EN 10025 A36 IS 2062 OTHER STRUCTURAL STEEL GRADES; AS UPTO GR.-22.
		$				SAIL	BHILAI/SALEM	A		CS- SA515 BS EN 10025 A36 IS 2062 OTHER STRUCTURAL STEEL GRADES; AS UPTO GR.-22.
		$				NIPPON STEEL	JAPAN	A		CS- SA515 BS EN 10025 A36 IS 2062 OTHER STRUCTURAL STEEL GRADES; AS UPTO GR.-22.
		$				POSCO	KOREA	A		CS- SA515 BS EN 10025 A36 IS 2062 OTHER STRUCTURAL STEEL GRADES; AS UPTO GR.-22.

Bharat Heavy Electricals Limited ★ PS-MKTG Delhi ★

Patratu Vidyut Utpadan Nigam Limited ★ Distt-Ramgarh(Jharkhand) ★ C & M Deptt. 4/6

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	Project:	PATRATU	3x800	MW	LIST OF ITEMS REQUIRING QUALITY PLAN			DOC. NO. :	CS-9585-001-2	
					AND SUB-SUPPLIER APPROVAL			REV. NO. :		
	Package:	EPC						DATE:	06.04.2017	
	Supplier:	BHEL								
	Contract No.:	CS-9585-001-2			SUB-SYS	STEAM GENERATOR/RAW MATERIALS				

S.No.	ITEM	QP/Insp. Cat.	QP No.	QP Sub-Schedule	QP approval schedule	Proposed sub-supplier	Place	Suppliers approval status/ category	supplier Details submissio n schedule	Remarks
		$				REINER BRACH GMBH & CO.	GERMANY	A		CS- SA 299 SA515 BS EN 10025 A35 IS 2062 OTHER STRUCTURAL STEEL GRADES; AS UPTO GR.-22.
		$				JFE	JAPAN	DR		
		$				CLABECQ	BELGIUM	DR		
		$				JSPL	INDIA	DR		
		$				DUFERCO	GERMANY	DR		
		$				GULDE	GERMANY	A		MEMBRANE FINS UPTO GR-22
		$				ARCELLOR MITTAL	ROMANIA	DR		
		$				METAL ONE	JAPAN	DR		MEMBRANE FINS UPTO GR-12
		$				LLYODS STEEL INDUS LTD(UTTAM VALUE STEEL)	INDIA	A		UPTO GR.-22; SUBJECT TO CONDITION
7	PLATES & ROLLED SECTION(CS)	$				ARCELLOR MITTAL GALATI	ROMANIA	A		CS PLATES UPTO 80 MM
		$				JSW STEEL LTD.	INDIA	A		STRUCTURAL STEEL
		$				RINL	INDIA	A		STRUCTURAL STEEL
		$				ESSAR STEEL LTD.	INDIA	A		STRUCTURAL STEEL
		$				TISCO	INDIA	A		STRUCTURAL STEEL
		$				LLYODS STEEL INDUS LTD(UTTAM VALUE STEEL)	INDIA	A		STRUCTURAL STEEL
		$				ISPAT INDUSTRIES LTD.	INDIA	A		STRUCTURAL STEEL
		$				JSPL	INDIA	A		STRUCTURAL STEEL
		$				SAIL	INDIA	A		STRUCTURAL STEEL
8	PLATES(SS)	$				OUTOKUMPU	SWEDEN	A		SS PLATES UPTO 20 MM THK
		$				INDUS STEEL	BELGIUM	A		GR-304,309,310,316

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	Project:	PATRATU	3x800	MW	LIST OF ITEMS REQUIRING QUALITY PLAN			DOC. NO. :	CS-9585-001-2	
					AND SUB-SUPPLIER APPROVAL			REV. NO. :		
	Package:	EPC						DATE:	06.04.2017	
	Supplier:	BHEL								
	Contract No.:	CS-9585-001-2			SUB-SYS	STEAM GENERATOR/RAW MATERIALS				

S.No.	ITEM	QP/Insp. Cat.	QP No.	QP Sub-Schedule	QP approval schedule	Proposed sub-supplier	Place	Suppliers approval status/ category	supplier Details submission schedule	Remarks
		$				JSL STAINLESS	JAIPUR	A		LINER SS 304
		$				INDUSTEEL LOIRE	FRANCE	A		GR-304,309,310,316
		$				SAIL	BHILAI/SALEM	A		GR-304,309,310,317
		$				COLUMBUS STAINLESS STEEL(ACRINOX)	SOUTH AFRICA	A		GR-304,309,310,318
		$				NIPPON STEEL CORP.	JAPAN	DR		
		$				THYSEEN KRUPP	GERMANY	DR		
		$				SUMITOMO	JAPAN	DR		
		$				ACRONI SLOVENIS	JAPAN	DR		
		$				DKC	KOREA	DR		
9	ALUMINIUM CLADDING	III				MAIN CONTRACTOR'S APPROVED SOURCES				

NOTE 1:	VENDORS UNDER A(ACCEPTED CATEGORY) ARE APPROVED AND ACCEPTED BY NTPC IN PAST WITH OR WITHOUT CONDITIONS. SIMILAR CONDITIONS AS THE CASE MAY BE SHALL BE APPLICABLE FOR THIS PROJECT ALSO.
NOTE 2:	VENDORS UNDER DR (DETAILS REQUIRED) CATEGORY SHALL BE REQUIRED TO SUBMIT THE DETAILS IN NTPC QUESTIONNAIRE.
NOTE 3:	PRE DESPATCH INSPECTION FOR ALLOY/SS GRADES NEEDS TO BE TIED UP BY MAIN CONTRACTOR OR THIRD PARTY INSPECTION AGENCY AS REQUIRED.
NOTE 4:	($) REVIEW OF MILL TC FOR RAW MATERIAL TO BE DONE BY NTPC AND SHALL BE INCLUDED IN THE QP OF CORRESPONDING EQUIPMENT.

06-4-2017

Bharat Heavy Electricals Limited PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited C & M Deptt. Dist-Ramgarh(Jharkhand)

	Project:	PATRATU 3x800 MW			LIST OF ITEMS REQUIRING QUALITY PLAN			DOC. NO.:	CS-9585-001-2	
					AND SUB-SUPPLIER APPROVAL			REV. NO.:	0	
	Package:	Steam Generator Island Package						DATE:	04.04.2017	
	Supplier:	BHEL			BHEL TRICHY					
	Contract No.:	CS-9585-001-2			SUB-SYST STEAM GENERATOR					
S.No.	ITEM	QP/Insp. Cat.	QP No.	QP Sub-Schedule	QP approval schedule	Proposed sub-supplier	Place	Suppliers approval status/ category	supplier Details submission	Remarks
1	SEPARATOR & STORAGE TANK	I				ALSTOM	USA	A		
		I				BHEL	TRICHY	A		
		I				ALSTOM	DURGAPUR	A		
		I				SHANGHAI BOILER WORKS	CHINA	DR		
		I				ALSTOM SURABHAYA	INDONESIA	DR		
		I				ALSTOM	WUHAN	DR		
2	HEADERS AND SUCTION MANIFOLDS	I				ALSTOM	USA	A		
		I				BHEL	TRICHY	A		
		I				ALSTOM	DURGAPUR	A		
		I				SHANGHAI BOILER WORKS	CHINA	DR		
		I				ALSTOM SURABHAYA	INDONESIA	DR		
3	TUBULAR PRODUCTS-ONLY SPIRAL WALLS	I				BHEL	TRICHY	A		
		I				ALSTOM	DURGAPUR	A		
		I				ALSTOM	USA	A		
		I				SHANGHAI BOILER WORKS	CHINA	DR		
		I				ALSTOM WUHAN	CHINA	DR		
		I				ALSTOM SURABHAYA	INDONESIA	DR		
4	TUBULAR PRODUCTS (COILS & PANELS) EXCLUDING SPIRAL WALL	I				ALSTOM	DURGAPUR	A		
		I				BHEL	TRICHY	A		
		I				ALSTOM	USA	A		

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Patratu Vidyut Utpadan Nigam Limited C & M Deptt. Distt-Ramgarh(Jharkhand)

(NITIN KUMAR) PS-M BHEL

	Project:	PATRATU	3x800	MW	LIST OF ITEMS REQUIRING QUALITY PLAN			DOC. NO.:	CS-9585-001-2	
					AND SUB-SUPPLIER APPROVAL			REV. NO.:	0	
	Package:	Steam Generator Island Package						DATE:	04.04.2017	
	Supplier:	BHEL				BHEL TRICHY				
	Contract No.:	CS-9585-001-2			SUB-SYST	STEAM GENERATOR				

S.No.	ITEM	QP/Insp. Cat.	QP No.	QP Sub-Schedule	QP approval schedule	Proposed sub-supplier	Place	Suppliers approval status/ category	supplier Details submissio n	Remarks
5	CRITICAL PIPING / PCP (MS, CRH,HRH & FW) AND BOILER PIPING	I				BHEL	TRICHY	A		
		I				ALSTOM	DURGAPUR	A		
6	MISC HP PIPING EXCLUDING CRITICAL PIPING (CS, AS UPTO 91 GRADE)	I				BHEL	TRICHY	A		
		I				ALSTOM	DURGAPUR	A		
7	NON IBR PIPING / LP PIPING (Pr upto 10 Ksc)	III				MAIN CONTRACTOR'S APPROVED SOURCES				
8	FORMED FITTINGS(Gr91)	I				BHEL	TRICHY	A		
9	SPHERES	I				ALSTOM	DURGAPUR	A		
		I				BHEL	TRICHY	A		
		I				ALSTOM	USA	A		
10	GRAVIMETRIC COAL FEEDERS	I				REFER SUB OR LIST				
11	RAW COAL GATE ASSEMBLY FOR GRAVEMETRIC FEEDER	I				BHEL	TRICHY	A		
12	COAL BURNER ASSY & SOFA	I				ALSTOM	USA	A		
		I				BHEL	TRICHY	A		
13	AIR COOLED OIL GUN ASSEMBLY	I				BHEL	TRICHY	A		
14	OIL PREHEATER & PRESSURISING SKID ASSY.	III				MAIN CONTRACTOR'S APPROVED SOURCES				
15	HFO/LFO PUMPS	I				ALWEILER	GERMANY	A		
		I				BOURMANN	GERMANY	A		

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★ Patratu Vidyut Utpadan Nigam Limited ★ C & M Deptt. Distt. Ramgarh (Jharkhand)

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	Project:	PATRATU	3x800	MW	LIST OF ITEMS REQUIRING QUALITY PLAN			DOC. NO.:	CS-9585-001-2	
					AND SUB-SUPPLIER APPROVAL			REV. NO. :	0	
	Package:	Steam Generator Island Package						DATE:	04.04.2017	
	Supplier:	BHEL			BHEL TRICHY					
	Contract No.:	CS-9585-001-2			SUB-SYST STEAM GENERATOR					

S.No.	ITEM	QP/Insp. Cat.	QP No.	QP Sub-Schedule	QP approval schedule	Proposed sub-supplier	Place	Suppliers approval status/ category	supplier Details submission	Remarks
		I				TUSHACO PUMPS	DAMAN	A		SCREW TO BE IMPORTED FROM ALLWEILLER GERMANY
		I				LEISTRITZ	GERMANY	A		
		I				BOURMANN	GERMANY	A		
		I				KRAL	AUSTRIA	A		
		I				ALEKTON	CHENNAI	A		
		I				UT PUMPS	FARIDABAD	A		SUBJECT TO CONDITIONS .
16	SOOT BLOWERS(LRSB,WALL DESLAGGER, ROTARY BLOWER,TEMP. PROBE)	I				BHEL	TRICHY	A		
17	ELECTRIC HOIST WITH TROLLEY, UNDERSLUNG CRANE	I								Main BOIs eg. Hook, motors and C&I item from NTPC approved sources
		I				CONSOLIDATED HOISTS	SATARA	A		EOT CRANES UPTO 40 TONS & HOISTS UPTO 40 TONS.
		I				POWER BUILD P LTD	VV NAGAR	A		HOIST UPTO 10 TONS
		I				CONSOLIDATED HOISTS	PUNE	A		HOIST UPTO 20 TONS
		I				TRACTOR TRIFOR	FARIDABAD	A		HOIST UPTO 15 TONS
		I				HERCULES HOIST LTD.	MUMBAI	A		HOIST UPTO 30 TONS
		I				GRIP ENGINEERS	HYDERABAD	A		HOIST UPTO 40 TONS
		I				ANUPAM INDUSTRIES	VITHAL UDYOGNAGAR	A		EOT CRANES UPTO 50 TONS
		I				DYNAMECH CRANES	THANE,MUMBAI	A		UPTO 20 TONS
		I				ARMSEL MHE PVT. LTD.	BANGALORE	A		UPTO 20 TONS
		I				HERCULES HOIST LTD.	MUMBAI	A		HOIST UPTO 20 TONS
		I				UNIVERSAL HOIST	THANE,	A		HOIST UPTO 20 TONS
		I				LIFTING EQUIPMENTS	DELHI	DR		
		I				TECHNO INDUSTRIES	AHMEDABAD	DR		

Bharat Heavy Electricals Limited PS-MKTG Delhi

Utpadan Nigam Limited * Patratu Vidyut * Distt-Ramgarh(Jharkhand) * C & M Deptt. 3/14

	Project:	PATRATU	3x800	MW	LIST OF ITEMS REQUIRING QUALITY PLAN			DOC. NO.:	CS-9585-001-2	
					AND SUB-SUPPLIER APPROVAL			REV. NO.:	0	
	Package:	Steam Generator Island Package						DATE:	04.04.2017	
	Supplier:	BHEL			BHEL TRICHY					
	Contract No.:	CS-9585-001-2			SUB-SYST	STEAM GENERATOR				
S.No.	ITEM	QP/Insp. Cat.	QP No.	QP Sub-Schedule	QP approval schedule	Proposed sub-supplier	Place	Suppliers approval status/ category	supplier Details submission	Remarks
18	ELECTRIC HOIST WITH TROLLEY, UNDERSLUNG CRANE - CAPACITY UPTO 5 TONS	III				MAIN CONTRACTOR'S APPROVED SOURCES				
19	RECIRCULATION PUMP	I				REFER SUB QR ITEMS LIST				
20	LP CONDENSATE TRANSFER PUMP	I				ITT GOULD	USA	A		
		I				FLOW SERVE	USA	A		
		I				SULZER	NAVI MUMBAI	A		
21	AUXILIARY BOILER	I				REFER SUB QR ITEMS LIST				
22	SCANNER AIR FAN	I				ANDREW YLE	KOLKATA	A		
		I				ACCEL	AHMEDABAD	A		
		I				PATEL AIRTEMP(I) LTD.	AHMEDABAD	A		
		I				TLT INDIA	GUJARAT	A		
		I				BHEL,BAP	RANIPET	A		
		I				CB DOCTOR(IMM)	AHMEDABAD	A		
		I				AIROCHEN ENGG. CO.	KOLHAPUR	DR		
		I				AR CONTROL & CHEM ENGG. CO. LTD.	MUMBAI	DR		

Bharat Heavy Electricals Limited * PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited * (Distt.-Ramgarh(Jharkhand)) C & M Deptt.

	Project:	PATRATU	3x800	MW	LIST OF ITEMS REQUIRING QUALITY PLAN			DOC. NO.:	CS-9585-001-2	
					AND SUB-SUPPLIER APPROVAL			REV. NO. :	0	
	Package:	Steam Generator Island Package						DATE:	04.04.2017	
	Supplier:	BHEL			BHEL TRICHY					
	Contract No.:	CS-9585-001-2			SUB-SYST STEAM GENERATOR					

S.No.	ITEM	QP/Insp. Cat.	QP No.	QP Sub-Schedule	QP approval schedule	Proposed sub-supplier	Place	Suppliers approval status/ category	supplier Details submission	Remarks
23	SEAL AIR FAN	I				CB DOCTOR & CO.	AHMEDABAD	A		
		I				ACCEL	AHMEDABAD	A		
		I				TLT INDIA	AHMEDABAD	A		
		I				PATEL AIRTEMP(I) LTD.	AHMEDABAD	A		
		I				BHEL,BAP	RANIPET	A		
		I				ANDREW YLE	KOLKATA	A		
24	FURNACE MAINT. PLATFORM(SKY CLIMBER)	I				NV SKYMAN INT. SA	BELGIUM	A		
		I				NV SKCLIMBER EUROPE SA	BELGIUM	A		
		I				POWER CLIMBER	BELGIUM	DR		
		I				DAEO PRECISION	KOREA	A		
		I				HINGWING GONDOLA	HONGKONG	DR		
25	QUICK ERECT FURNACE SCAPPHOLDING	II								VENDORS TO BE PROPOSED LATER DURING PROJECT EXECUTION
26	METALLIC EXPANSION JOINT	I				BHEL	TRICHY	A		

Bharat Heavy Electricals Limited PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited * Distt.: Ramgarh (Jharkhand) * C & M Deptt.

	Project:	PATRATU 3x800 MW			LIST OF ITEMS REQUIRING QUALITY PLAN			DOC. NO.:	CS-9585-001-2	
					AND SUB-SUPPLIER APPROVAL			REV. NO. :	0	
	Package:	Steam Generator Island Package						DATE:	04.04.2017	
	Supplier:	BHEL			BHEL TRICHY					
	Contract No.:	CS-9585-001-2			SUB-SYST STEAM GENERATOR					
S.No.	ITEM	QP/Insp. Cat.	QP No.	QP Sub-Schedule	QP approval schedule	Proposed sub-supplier	Place	Suppliers approval status/ category	supplier Details submissio n	Remarks
27	DUCT ASSY,FLOWMETER WEIGHTING UPTO 10 TONS	III				MAIN CONTRACTOR'S APPROVED SOURCES				
28	DUCT ASSY TRANSISTION PIECE, DUCT ASSY,FLOWMETERS WEIGHTING> 10 TONS	III				MAIN CONTRACTOR'S APPROVED SOURCES				Trial Assembly Audit Check by NTPC.
29	LIGHT BONDED MINERAL WOOL	I				MINWOOL ROCK FIBRES LTD.	RAJNANDAON, BHILAI	A		
		I				LAPINUS ROCKWOOL LTD.	GWALIOR	A		
		I				LLOYDS INSULATION, CHENNAI	BHILAI	A		
		I				PUNJSTAR INSULATION	BHILAI	A		
		I				GOENKA ROCK WOOL	RAIPUR	A		
		I				THERMOCARE ROCKWOOL PVT. LTD. ES. LTD.	RAJNANDAON	A		
		I				SHREERAM EQUITECH	DURG	A		
		I				MINWOOL ROCK FIBRES LTD.	RAJNANDAON, BHILAI	A		
		I				ROCKWOOL INDIA LTD.	MEDAK-AP	A		
		I				DHANBAD ROCKWOOL INSULATION PVT. LTD.	DHANBAD	A		
		I				MINSULATE MFG. CO.	JAMSHEDPUR	A		
		I				POLYBOND PROJECTS PVT. LTD.	DURG	A		
						HI-TECH ROCK FIBRE LTD.	RAJNANDGOAN	A		
						JAMSHEDPUR MINERAL WOOL	JAMSHEDPUR	A		
						ROCKWOOL INDUSTRIES	BHILAI	A		
30	CASTABLE REFRACTORY	III				MAIN CONTRACTOR'S APPROVED SOURCES				
31	POURABLE INSULATION	III				MAIN CONTRACTOR'S APPROVED SOURCES				
32	CLH & VLH	I				BHEL	TRICHY			other vendorS as per BHEL PIPING CENTER LIST

Bharat Heavy Electricals Limited PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited Distt. Ramgarh (Jharkhand) C & M Deptt.

	Project:	PATRATU	3x800	MW	LIST OF ITEMS REQUIRING QUALITY PLAN			DOC. NO.:	CS-9585-001-2	
					AND SUB-SUPPLIER APPROVAL			REV. NO. :	0	
	Package:	Steam Generator Island Package						DATE:	04.04.2017	
	Supplier:	BHEL			BHEL TRICHY					
	Contract No.:	CS-9585-001-2			SUB-SYST	STEAM GENERATOR				
S.No.	ITEM	QP/Insp. Cat.	QP No.	QP Sub-Schedule	QP approval schedule	Proposed sub-supplier	Place	Suppliers approval status/ category	supplier Details submission	Remarks
		I				BHEL HERP	VARANASI			
33	HANGER & SUPPORTS-(OTHER THAN CLH & VLH)	III				MAIN CONTRACTOR'S APPROVED SOURCES				
34	CONVENTIONAL VALVES(GATE,GLOBE & CHECK)									91/92 GRADE CASTINGS FOR CONVENTIONAL VALVES SHALL BE FROM MAIN CONTRACTOR'S APPROVED SOURCES WHICH ARE HAVING ELECTRIC ARC FURNACE, VOD AND LRF FACILITIES
		I				BHEL	TRICHY	A		CONVENTIONAL VALVES(GATE,GLOBE & CHECK) BHEL RANGE, 2/3 WAY VALVES
		I				VELAN	H4T1X8 MONTREAL CANADA	A		GATE/CHECK V/V UPTO 22"CI 2500
		I				LEADER VALVES	JALANDHAR	A		CCS GLOBE V/X 24" CI 600, GLOBE V/V 24"CI 300,CHECK V/V 24"CI 600
		I				CRESCENT VALVES	MUMBAI	A		UPTO NB 300 CL 600
		I				VELAN VALVE CORP	USA	A		GATE V/V 2-24"CI 900-4500,CAST STEEL GATE V/V 18-48"CI150-600
		I				VELAN	UK	A		1) GLOBE V/V 1/4"-2"CI4500 ,2) BONNETLESS GLOBE V/V 1/2-2.5"CI 150-600)
		I				VELAN	QUBEC CANADA	A		GATE/GLOBE/CHECK V/V UPTO 3"CI 2680
		I				L&T VALVES	COIMBATORE	A		1) CAST 2500 CI GATE(CS &AS) UPTO 20" & CHECK(CS&AS) UPTO 16"; 2) FORGED 4500 CI(CS&AS) GATE UPTO 1" & GLOBE/CHECK UPTO 2".

Bharat Heavy Electricals Limited PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited C & M Deptt. Distt-Ramgarh(Jharkhand)

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	Project:	PATRATU 3x800 MW			LIST OF ITEMS REQUIRING QUALITY PLAN			DOC. NO.:	CS-9585-001-2	
					AND SUB-SUPPLIER APPROVAL			REV. NO. :	0	
	Package:	Steam Generator Island Package						DATE:	04.04.2017	
	Supplier:	BHEL				BHEL TRICHY				
	Contract No.:	CS-9585-001-2			SUB-SYST	STEAM GENERATOR				
S.No.	ITEM	QP/Insp. Cat.	QP No.	QP Sub-Schedule	QP approval schedule	Proposed sub-supplier	Place	Suppliers approval status/ category	supplier Details submission	Remarks
		I				BDK	HUBLI	A		UPTO NB 300 & CL 600,FORGED UPTO NB 50 CL. 800
		I				FOURESS ENG. INDIA LTD.	MUMBAI	A		UPTO NB 200 CL 600,NB 250-600 CL 300
		I				NITTON VALVES	AURANGABAD	A		WCB/WCC(GATE VALVE UPTO 36" Cl 600)
		I				SAMSHIN	SOUTH KOREA	A		2500 CL GATE/GLOBE/CHECK UPTO 24"; CL 3500 GATE UPTO 18" & GLOBE UPTO 6"; 4500 CL GATE UPTO 6" & GLOBE/CHECK/ANGLE UPTO 2"
		I				VELAN	H4T1G2 MONTREAL CANADA	A		GATE/GLOBE/CHECK UPTO 24"Cl 4500
		I				VELAN	PORTUGAL	A		CAST STEEL GATE/GLOBE/CHECK 2-12"Cl 150-600
		I				ROCKWELL	USA	A		APPROVAL RANGE AS PER NTPC APPROVAL LETTER
		I				CRIS	FRANCE	A		APPROVAL RANGE AS PER NTPC APPROVAL LETTER
		I				OKANO VALVES	JAPAN	A		APPROVAL RANGE AS PER NTPC APPROVAL LETTER
		I				RAIMONDI	ITALY	A		APPROVAL RANGE AS PER NTPC APPROVAL LETTER
		I				HP VALVES	NEITHERLANDS	A		TRIM VALVES;APPROVAL RANGE AS PER NTPC APPROVAL LETTER
		I				FLOW SERVE	USA	A		APPROVAL RANGE AS PER NTPC APPROVAL LETTER
		I				DRESSER MASONEILAN	USA	A		APPROVAL RANGE AS PER NTPC APPROVAL LETTER

Bharat Heavy Electricals Limited ★ PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited ★ Distt-Ramgarh(Jharkhand) C & M Deptt.

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	Project:	PATRATU	3x800	MW	LIST OF ITEMS REQUIRING QUALITY PLAN			DOC. NO.:	CS-9585-001-2	
					AND SUB-SUPPLIER APPROVAL			REV. NO. :	0	
	Package:	Steam Generator Island Package						DATE:	04.04.2017	
	Supplier:	BHEL			BHEL TRICHY					
	Contract No.:	CS-9585-001-2			SUB-SYST STEAM GENERATOR					

S.No.	ITEM	QP/Insp. Cat.	QP No.	QP Sub-Schedule	QP approval schedule	Proposed sub-supplier	Place	Suppliers approval status/ category	supplier Details submission	Remarks
		I				OKANO VALVES	JAPAN	A		APPROVAL RANGE AS PER NTPC APPROVAL LETTER
		I				TOA	JAPAN	A		APPROVAL RANGE AS PER NTPC APPROVAL LETTER
		I				CRIS	FRANCE	A		APPROVAL RANGE AS PER NTPC APPROVAL LETTER
		I				TYCO SEMPELL	GERMANY	A		APPROVAL RANGE AS PER NTPC APPROVAL LETTER
		I				MIL CONTROLS	KERALA	A		APPROVAL RANGE AS PER NTPC APPROVAL LETTER
		I				FOURESS ENG. INDIA LTD.	INDIA	A		APPROVAL RANGE AS PER NTPC APPROVAL LETTER
		I				DEUTSCHE BABCOCK	GERMANY	A		APPROVAL RANGE AS PER NTPC APPROVAL LETTER
		I				KSB	COIMBATORE	A		APPROVAL RANGE AS PER NTPC APPROVAL LETTER
		I				SPX PROCESS EQUIPMENTS/COPES VULCAN	USA	A		APPROVAL RANGE AS PER NTPC APPROVAL LETTER
		I				TOA/MEIWA	JAPAN	A		APPROVAL RANGE AS PER NTPC APPROVAL LETTER
		I				RAIMONDI	ITALY	A		APPROVAL RANGE AS PER NTPC APPROVAL LETTER
		I				BABCOCK BORSING	ESPANA	A		APPROVAL RANGE AS PER NTPC APPROVAL LETTER
		I				DEWARNCE	UK	A		APPROVAL RANGE AS PER NTPC APPROVAL LETTER
35	SAFETY VALVE(SPRING TYPE)	I				DRESSER	USA	A		
		I				SEMPELL AG	GERMANY	A		
		I				TYCO(PENTAIR VALVES & CONTROLS)	USA	A		
		I				FUKUI	JAPAN	A		
		I				RIENEKE GMBH	GERMANY	A		HYD TYPE

Bharat Heavy Electricals Limited PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited * Distt-Ramgarh(Jharkhand) * C & M Deptt. 9/14

	Project:	PATRATU	3x800	MW	LIST OF ITEMS REQUIRING QUALITY PLAN			DOC. NO. :	CS-9585-001-2	
					AND SUB-SUPPLIER APPROVAL			REV. NO. :	0	
	Package:	Steam Generator Island Package						DATE:	04.04.2017	
	Supplier:	BHEL				BHEL TRICHY				
	Contract No.:	CS-9585-001-2			SUB-SYST	STEAM GENERATOR				

S.No.	ITEM	QP/Insp. Cat.	QP No.	QP Sub-Schedule	QP approval schedule	Proposed sub-supplier	Place	Suppliers approval status/ category	supplier Details submissio n	Remarks
		I				BOPP & REUTHER	GERMANY	A		HYD TYPE
		I				VALVE TECHNOLOGIES	USA	A		APPROVAL RANGE AS PER NTPC APPROVAL LETTER
		I				MEIWA	JAPAN	A		APPROVAL RANGE AS PER NTPC APPROVAL LETTER
		I				BHEL	TRICHY	A		
36	ERV	I				VALVE TECHNOLOGIES	USA	A		
		I				FUKUI	JAPAN	A		
		I				SEMPELL AG	GERMANY	A		
		I				DRESSER	USA	A		
		I				MEI WA CORP.	JAPAN	A		APPROVAL RANGE AS PER NTPC APPROVAL LETTER
		I				RIENEKE GMBH	GERMANY	A		APPROVAL RANGE AS PER NTPC APPROVAL LETTER
37	PLUG VALVE	I				FLOW SERVE INDIA CONTROLS	KANCHIPURAM	A		UPTO 150 NB CI 300,UPTO 400 NB CI 150
						HAWA VALVES	MUBAI	A		UPTO 8" SIZE AND CLASS 300
		I				3Z CORP.	KOREA	A		UPTO 10" SIZE AND CLASS 300
		I				BDK	HUBLI	A		APPROVAL RANGE AS PER NTPC APPROVAL LETTER
		I				ZED VALVES CO. PVT. LTD.	AHMEDABAD	DR		
38	SAFETY VALVE SILENCERS	III				MAIN CONTRACTOR'S APPROVED SOURCES				

Bharat Heavy Electricals Limited PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited C & M Deptt. Distt-Ramgarh(Jharkhand)

	Project:	PATRATU 3x800 MW			LIST OF ITEMS REQUIRING QUALITY PLAN			DOC. NO. :	CS-9585-001-2	
					AND SUB-SUPPLIER APPROVAL			REV. NO. :	0	
	Package:	Steam Generator Island Package						DATE:	04.04.2017	
	Supplier:	BHEL				BHEL TRICHY				
	Contract No.:	CS-9585-001-2			SUB-SYST	STEAM GENERATOR				
S.No.	ITEM	QP/Insp. Cat.	QP No.	QP Sub-Schedule	QP approval schedule	Proposed sub-supplier	Place	Suppliers approval status/ category	supplier Details submissio n	Remarks
39	PRIMARY STRUCTURE - CEILING GIRDERS, MAIN COLUMNS, AUX COLUMNS, BUILT UP BEAMS, BOXES, BUCKSTAY, BRACINGS, MILL BAY STR, APH SUPPORT STR, TRANSFER TOWER	I				NTPC APPROVED VENDORS				PROJECT SPECIFIC APPROVAL OF EACH VENDOR TO BE TAKEN BY BHEL FROM NTPC; VENDOR TO MEET TECH. SPEC. REQUIREMENTS FOR STR. FABRICATION
40	BUCK STAY, BRACINGS MFD FROM ROLLED SECTIONS	III				MAIN CONTRACTOR'S APPROVED SOURCES				VENDOR TO MEET TECH. SPEC. REQUIREMENTS FOR STR. FABRICATION
41	SECONDARY STRUCTURE-PLATFORMS , GALLERIES , WALKWAY, STAIRCASE, LADDER, DUCT SUPPORT STRUCTURE, ANCHOR BOLTS ETC	III				MAIN CONTRACTOR'S APPROVED SOURCES				VENDOR TO MEET TECH. SPEC. REQUIREMENTS FOR STR. FABRICATION
42	ELECTROFORGED GRATINGS	II				INDIANA GRATINGS P. LTD.	PUNE	A		
		II				KARDE ANAND UDYOG	PUNE	A		
		II				PREMIER POWER PROJ.	HOWRAH	A		
		II				BHOLA RAM STEEL	PATNA	A		
		II				PINAX STEEL	PATNA	A		
		II				GREATWELD	PUNE	A		
		II				VIN FAB ENGG. PVT. LTD.	MUMBAI	A		
43	STRAINERS	III				MAIN CONTRACTOR'S APPROVED SOURCES				

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Patratu Vidyut Utpadan Nigam Limited C & M Deptt. 11/14 Distt-Ramgarh(Jharkhand)

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	Project:	PATRATU	3x800	MW	LIST OF ITEMS REQUIRING QUALITY PLAN		DOC. NO. :	CS-9585-001-2	
					AND SUB-SUPPLIER APPROVAL		REV. NO. :	0	
	Package:	Steam Generator Island Package					DATE:	04.04.2017	
	Supplier:	BHEL			BHEL TRICHY				
	Contract No.:	CS-9585-001-2			SUB-SYST STEAM GENERATOR				

S.No.	ITEM	QP/Insp. Cat.	QP No.	QP Sub-Schedule	QP approval schedule	Proposed sub-supplier	Place	Suppliers approval status/ category	supplier Details submissio n	Remarks
44	CERAMIC LINED COAL PIPES & BENDS	I				BHEL EDN	BANGALORE	A		
						BHEL	JAGDISHPUR	A		
45	COAL PIPES & BENDS(W/O CERAMIC LINES)	III				MAIN CONTRACTOR'S APPROVED SOURCES				
46	COAL BUNKER	I				NTPC APPROVED VENDORS				VENDORS TO BE PROPOSED LATER DURING PROJECT EXECUTION
47	SOOT BLOWER PRESSURE REDUCING VALVES & BLOCK					REFER C&I VENDOR LIST				
48	91/92 GRADE FITTINGS (NOTE 6)	I								
		I				PETROL RACCORD SPA	ITALY	A		P-91, P-92 FORMED/FORGED
		I				BOKOYOUNG METAL CO.	LOREA	A		P-91,FORGED
		I				TF TECH CO. LTD.	KOREA	A		P-91 FORGED
		I				FLASH FORGE	VIZAG	A		91 WITH SIZE/TYPE CONDITIONS AS PER NTPC APPROVAL LETTER
		I				BGH EDELSTAHL SIEGEN GMBH	GERMANY	A		P-91 FORGED
		I				ERNE FITTINGS GMBH	AUSTRIA	A		P-91 FORMED
		I				GAM RACCORDI SPA	ITALY	A		P-91 FORMED

Bharat Heavy Electricals Limited PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited Distt-Ramgarh(Jharkhand) C & M Deptt.

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	Project:	PATRATU 3x800 MW			LIST OF ITEMS REQUIRING QUALITY PLAN			DOC. NO.:	CS-9585-001-2	
					AND SUB-SUPPLIER APPROVAL			REV. NO. :	0	
	Package:	Steam Generator Island Package						DATE:	04.04.2017	
	Supplier:	BHEL			BHEL TRICHY					
	Contract No.:	CS-9585-001-2			SUB-SYST STEAM GENERATOR					

S.No.	ITEM	QP/Insp. Cat.	QP No.	QP Sub-Schedule	QP approval schedule	Proposed sub-supplier	Place	Suppliers approval status/ category	supplier Details submissio n	Remarks
		I				TECHNO FORGE SPA	ITALY	A		P-91, P-92 FORMED
		I				MEGA SPA	ITALY	A		P-91 FORGED/WELDED
		I				BASSI LLUIGI SPA	ITALY	A		P-91 FORGED/WELDED
		I				IBF SPA	ITALY	A		P-91, P-92 FORMED/FORGED
		I				ALLIED INT. (TACTUBI RACCORDI SPA, VIA ROMA 150, 29027 PODENZANO)	ITALY	A		P-91, P-92 FORMED
		I				BRUCK STRASSE 16 ENSHEIM	GERMANY	A		P-91 FORGED/WELDED
		I				SUNGKWANG BEND CO. LTD.	KOREA	A		P-91/F-91 FORMED/FORGED/WELDED
		I				TK CORP. FORGITAL	KOREA	A		P-91 FORMED
						TIANJIN JINDING PIPING CO. LTD.	CHINA	A		91 FORMED (ELBOW, TEE, REDUCER)
						RINGMILL SPA	ITALY	A		FOR SEAMLESS AS (UPTO 91 GRADE) FORGED PIPE
		I				FORGITAL	ITALY	DR		
		I				DEE DEVELOPMENT	PALWAL	A		91 WITH SIZE/TYPE CONDITIONS AS PER NTPC APPROVAL LETTER
						CHW FORGE LTD.	GHAZAIBAD	A		91 WITH SIZE/TYPE CONDITIONS AS PER NTPC APPROVAL LETTER
						FORGE MONCHIERI SPA	ITALY	A		91 FORGING- WITH SIZE/TYPE CONDITIONS AS PER NTPC APPROVAL LETTER
						VIAR SPA	ITALY	DR		91 FORGINGS
						TIANJINDING PIPING CO. LTD.	CHINA	DR		
		I				AFFLERBACH	GERMANY	DR		
49	FITTINGS(CS,SS & AS UPTO GR 22)	II				MAIN CONTRACTOR'S APPROVED SOURCES				
50	KNIFE EDGE GATE VALVES(Mill Outlet and Burner Inlet)	I				GALAXY CONTROLS PVT. LTD.	CHENNAI	A		Upto size 26'

Bharat Heavy Electricals Limited PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited C & M Deptt. Distt-Ramgarh(Jharkhand)

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	Project:	PATRATU 3x800 MW			LIST OF ITEMS REQUIRING QUALITY PLAN			DOC. NO. :	CS-9585-001-2	
					AND SUB-SUPPLIER APPROVAL			REV. NO. :	0	
	Package:	Steam Generator Island Package						DATE:	04.04.2017	
	Supplier:	BHEL			BHEL TRICHY					
	Contract No.:	CS-9585-001-2		SUB-SYST	STEAM GENERATOR					
S.No.	ITEM	QP/Insp. Cat.	QP No.	QP Sub-Schedule	QP approval schedule	Proposed sub-supplier	Place	Suppliers approval status/ category	supplier Details submissio n	Remarks
		I				ORBINOX INDIA PVT.LTD.	COIMBATORE	A		Upto size 30"
		I				BRAY CONTOLS (VAAS INDUSTRIES PVT.LTD.)	CHENNAI	A		Upto size 28"
		I				JASH ENGG. LTD.	INDORE	A		UP TO SIZE 30
		I				GENERAL ENGG.CONSORTIUM	BANGALORE	DR		
51	SCR SYSTEM	I								REFER SUB QR LIST; VENDORS FOR SCR SUB ITEMS TO BE TIED UP AFTER SUB QR CLEARANCE ; L2 VENDORS SHALL BE DISCUSSED AND TIED UP AFTER FINALISATION OF L1 VENDOR

NOTE 1:	VENDORS UNDER A(ACCEPTED CATEGORY) ARE APPROVED WITH OR WITHOUT CONDITIONS IN PAST. SIMILAR CONDITIONS AS THE CASE MAY BE FOR THE VENDORS SHALL BE APPLICABLE FOR THIS PROJECT AND TIED UP IN THE QUALITY PLAN.
NOTE 2:	VENDORS UNDER DR (DETAILS REQUIRED) CATEGORY SHALL BE REQUIRED TO SUBMIT THE DETAILS IN NTPC QUESTIONNAIRE.
NOTE 3:	FOR EQUIPMENTS LIKE AUXILIARY BOILERS/HOISTS/GATES DAMPERS/LUB OIL SYSTEM,DOSING SSKID, G.FEEDERS THE MAJOR BOI SHALL BE AS PER NTPC APPD. LIST.
NOTE 4:	ALL MOTORS REQUIRED FOR PUMP-MOTOR/FAN-MOTOR ASSY,APH,GRAVIMETERIC FEEDER,PULVERISER SHALL BE FROM NTPC APPD. VENDOR LIST.
NOTE 5:	FOR MOTORISED/PNEUMATIC ACTUATED VALVES THE SUBSUPPLIERS FOR ACTUATORS SHALL BE AS PER NTPC APPD. LIST. REFER NTPC C&I LIST.
NOTE 6:	RAW MATERIAL FOR 91 AND ABOVE GRADE MATERIAL FITTINGS TO BE FROM NTPC APPROVED SOURCES AS PER RAW MATERIAL VENDOR LIST.

Bharat Heavy Electricals Limited ★ PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited ★ C & M Deptt. ★ Distt-Ramgarh(Jharkhand)

	Project:	PATRATU	3x800	MW	LIST OF ITEMS REQUIRING QUALITY PLAN			DOC. NO.:	CS-9585-001-2	
					AND SUB-SUPPLIER APPROVAL			REV. NO.:	0	
	Package:	EPC (SG SCOPE)						DATE:	05.04.2017	
	Supplier:	BHEL				BHEL, HYDERABAD				
	Contract No.:	CS-9585-001-2			SUB-SYST	MILLS				
S.No.	ITEM	QP/Insp. Cat.	QP No.	QP Sub-Schedule	QP approval schedule	Proposed sub-supplier	Place	Suppliers approval status/ category	Sub-supplier Details submission schedule	Remarks
1	MILL	I				REFER SUB QR LIST				FORMAL ACCEPTANCE AFTER SUB QR CLERANCE
2	PLANETARY GEAR BOX	I				BHEL	HYDERABAD	A		SUBJECT TO CONDITIONS
		I				SIEMENS	GERMANY	A		
3	GRINDING ROLL	I				AIA ENGG.	NAGPUR	A		SUBJECT TO SIZE CONDITIONS
		I				AIA ENGG.	AHMEDABAD	A		
		I				MEGOTTEAUX	RAJKOT	A		
		I				SHREE BALAJI INDUSTRIAL PRODUCTS	JAIPUR	DR		
4	BULL RING SEGMENTS	I				AIA ENGG.	AHMEDABAD	A		
		I				MEGOTTEAUX	RAJKOT	A		
5	MILL HANDLING	I								MAIN BOIs eg. Hook, motors and C&I item from NTPC approved sources
		I				POWER BUILT	V V NAGAR	A		Upto 10 Tons
		I				UNIVERSAL HOIST FABRIK	THANE/ MUMBAI	A		upto 20T Conditions
		I				DYNAMECH CRANES	THANE MUMBAI	A		upto 20T Conditions
		I				ANUPAM INDUSTRIES	V V MAGAR	A		EOT Cranes upto 50 Tons

Bharat Heavy Electricals Limited PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited * Distt-Ramgarh(Jharkhand) * C & M Deptt.

05.04.17
(Chittaranjan Samal, BHEL/Hyd

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	Project:	PATRATU	3x800	MW	LIST OF ITEMS REQUIRING QUALITY PLAN			DOC. NO.:	CS-9585-001-2	
					AND SUB-SUPPLIER APPROVAL			REV. NO. :	0	
	Package:	EPC (SG SCOPE)						DATE:	05.04.2017	
	Supplier:	BHEL				BHEL, HYDERABAD				
	Contract No.:	CS-9585-001-2			SUB-SYST	MILLS				
S.No.	ITEM	QP/Insp. Cat.	QP No.	QP Sub-Schedule	QP approval schedule	Proposed sub-supplier	Place	Suppliers approval status/ category	Sub-supplier Details submission schedule	Remarks
		I				GRIP ENGINEERS	HYDERABAD	A		Electrical hoist with trolley, under slung crane up to 40 Ton
		I				ARESEL MHE PVT LTD	BANGALROE	A		upto 20T
		I				CONSOLIDATED HOIST	PUNE	A		upto 20T Conditions
		I				CONSOLIDATED HOIST	SATARA	A		EOT CRANES UPTO 40 TONS & HOISTS ABOVE 15 TONS
		I				CENTURY CRANES	PALWAL	A		UPRO 30 MT EOT CRANES
		I				REVA INDUSTRIES	FARIDABAD	A		Upto25MT/Elec.Hoist
		I				GLOBAL TECHNOLOGY	HYDERABAD	DR		
		I				LIFTING EQUIPMENTS PVT. LTD.	DELHI	DR		
		I				SHIVAPRA CRANES	HYDERABAD	DR		
6	DYNAMIC CLASSIFIER	I				BHEL	HYDERABAD	DR		
7	LUB OIL SYSTEM	I				LINCOLN HELIOS	BANGALORE	A		
		I				T A HYDRAULICS	HYDERABAD	A		
		I				CENLUB INDUSTRIES	FARIDABAD	A		
		I				UNIQUE ENGINEERING ENTERPRISE P LTD	HYDERABAD	A		
		I				SOUTHERN LUB	BANGALORE	A		

Bharat Heavy Electricals Limited PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited C & M Deptt. Dist-Ramgarh(Jharkhand)

	Project:	PATRATU	3x800	MW	LIST OF ITEMS REQUIRING QUALITY PLAN			DOC. NO. :	CS-9585-001-2	
					AND SUB-SUPPLIER APPROVAL			REV. NO. :	0	
	Package:	EPC (SG SCOPE)						DATE:	05.04.2017	
	Supplier:	BHEL				BHEL, HYDERABAD				
	Contract No.:	CS-9585-001-2			SUB-SYST	MILLS				
S.No.	ITEM	QP/Insp. Cat.	QP No.	QP Sub-Schedule	QP approval schedule	Proposed sub-supplier	Place	Suppliers approval status/ category	Sub-supplier Details submission schedule	Remarks
		I				HYDAC	MUMBAI	DR		
		I				BHEL -HPEP	HYDERABAD	A		
8	RTD AND THERMOCOUPLE									DURING QP FINALISATION FROM C&I/ELECT LIST
9	SOLENOID VALVE									DURING QP FINALISATION FROM C&I/ELECT LIST
11	LIMIT SWITCH									DURING QP FINALISATION FROM C&I/ELECT LIST
12	SEPARATOR BODY	I				KCP	CHENNAI	A		
		I				SIMPLEX	BHILAI	A		
		I				NS ENGG.	HYDERABAD	A		
		I				ALSTOM PROJECTS INDIA LTD.	SHAHABAD	A		
		I				PREMIER ENGG. INDUSTRIES	JEEDIMETLA	A		
		I				SAI SARANG ENGINEERS	JEEDIMETLA	A		
		I				SWATHI INDUSTRIES	HYDERABAD	A		
		I				BHEL HPVP	VISAKHAPATNAM	A		
		I				GODREJ	MUMBAI	DR		
		I				BHEL CFU	JAGDISHPUR	DR		

Bharat Heavy Electricals Limited ★ PS-MKTG Delhi ★

Patratu Vidyut Utpadan Nigam Limited (Distt.-Ramgarh (Jharkhand)) C & M Deptt.

	Project:	PATRATU	3x800	MW	LIST OF ITEMS REQUIRING QUALITY PLAN			DOC. NO.:	CS-9585-001-2	
					AND SUB-SUPPLIER APPROVAL			REV. NO.:	0	
	Package:	EPC (SG SCOPE)						DATE:	05.04.2017	
	Supplier:	BHEL				BHEL, HYDERABAD				
	Contract No.:	CS-9585-001-2			SUB-SYST	MILLS				

S.No.	ITEM	QP/Insp. Cat.	QP No.	QP Sub-Schedule	QP approval schedule	Proposed sub-supplier	Place	Suppliers approval status/ category	Sub-supplier Details submission schedule	Remarks
		I				ISGEC	YAMUNANAGAR	DR		
13	PGB HOUSING	I				KCP	CHENNAI	A		
		I				SIMPLEX	BHILAI	A		
		I				NS ENGG.	HYDERABAD	A		
		I				GODREJ	MUMBAI	DR		
		I				ISGEC	MUMBAI	DR		
		I				BROWN'S HITECH STRUCTURES BHEL ANC.	HYDERABAD	A		
		I				SRI SRI ENGINEERING WORKS	HYDERABAD	A		
		I				TRIOMECH ENGINEERING	HYDERABAD	A		
		I				SWATHI INDUSTRIES	HYDERABAD	A		
		I				ALSTOM PROJECTS INDIA LTD.	SHAHABAD	DR		
		I				BHEL-HPVP	VISAKHAPATNAM	DR		
		I				BHEL-CSU	JAGDISHPUR	DR		
14	AIR IINLET HOUSING	I				ALSTOM PROJECTS INDIA LTD.	SHAHABAD	A		
		I				KCP	CHENNAI	A		
		I				NS ENGG.	HYDERABAD	A		
		I				SIMPLEX	BHILAI	A		
		I				SWATHI INDUSTRIES	HYDERABAD	A		

Bharat Heavy Electricals Limited PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited C & M Deptt. Distt-Ramgarh(Jharkhand)

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	Project:	PATRATU	3x800	MW	LIST OF ITEMS REQUIRING QUALITY PLAN			DOC. NO.:	CS-9585-001-2	
					AND SUB-SUPPLIER APPROVAL			REV. NO. :	0	
	Package:	EPC (SG SCOPE)						DATE:	05.04.2017	
	Supplier:	BHEL				BHEL, HYDERABAD				
	Contract No.:	CS-9585-001-2			SUB-SYST	MILLS				
S.No.	ITEM	QP/Insp. Cat.	QP No.	QP Sub-Schedule	QP approval schedule	Proposed sub-supplier	Place	Suppliers approval status/ category	Sub-supplier Details submission schedule	Remarks
		I				PREMIER ENGG. INDUSTRIES	JEEDIMETLA	A		
		I				SAI SARANG ENGINEERS	JEEDIMETLA	A		
		I				BHEL-HPVP	VISHAKHAPATNAM	A		
		I				HYDERABAD METCHAM	HYDERABAD	DR		
						GODREJ	MUMBAI	DR		
		I				BHEL CFU	JAGDISHPUR	DR		
		I				ISGEC	MUMBAI	DR		
15	SEPARATOR TOP	I				ALSTOM PROJECTS INDIA LTD.	SHAHABAD	A		
		I				KCP	CHENNAI	A		
		I				NS ENGG.	HYDERABAD	A		
		I				SIMPLEX	BHILAI	A		
		I				YOGASREE	BANGALORE	A		
		I				PREMIER ENGG. INDUSTRIES	JEEDIMETLA	A		
		I				SAI SARANG ENGINEERS	JEEDIMETLA	A		
		I				BHEL-HPVP	VISHAKHAPATNAM	A		
		I				GODREJ	MUMBAI	DR		
		I				BHEL CFU	JAGDISHPUR	DR		
		I				HYDERABAD METCHEM	HYDERABAD	DR		
16	MILL DISCHARGE VALVE (FABRICATED BODY & MPO) CERAMIC LINED	I				BHEL EPD	BANGALORE	A		

Bharat Heavy Electricals Limited ★ PS-MKTG Delhi

DVC ★ Patratu Vidyut Utpadan Nigam Limited ★ Ramgarh (Jharkhand) C & M Deptt.

	Project:	PATRATU	3x800	MW	LIST OF ITEMS REQUIRING QUALITY PLAN			DOC. NO.:	CS-9585-001-2	
					AND SUB-SUPPLIER APPROVAL			REV. NO. :	0	
	Package:	EPC (SG SCOPE)						DATE:	05.04.2017	
	Supplier:	BHEL				BHEL, HYDERABAD				
	Contract No.:	CS-9585-001-2			SUB-SYST	MILLS				
S.No.	ITEM	QP/Insp. Cat.	QP No.	QP Sub-Schedule	QP approval schedule	Proposed sub-supplier	Place	Suppliers approval status/ category	Sub-supplier Details submission schedule	Remarks
17	MILL COUPLING	II				SIEMENS	GERMANY	A		
		II				WELLMAN WACOMA LTD.	KOLKATA	DR		
		II				RATHI TRANSPOWER	PUNE	DR		
18	KNIFE EDGE GATE VALVES	I				GALAXY CONTROLS PVT. LTD.	CHENNAI	A		UP TO SIZE 26".
		I				ORBINOX INDIA PVT. LTD.	COIMBATORE	A		UP TO SIZE 30".
		I				BRAY CONTROLS (EARLIER-VAAS INDUSTRIES PVT. LTD.)	CHENNAI	A		UP TO SIZE 28".
		I				JASH ENGG. LTD.	INDORE	A		UP TO SIZE 30
		I				GENERAL ENGG. CONSORTIUM	BANGALORE	DR		

Bharat Heavy Electricals Limited * PS-MKTG Delhi *

Patratu Vidyut Utpadan Nigam Limited * C & M Deptt. * Distt-Ramgarh(Jharkhand)

	Project:	PATRATU	3x800	MW	LIST OF ITEMS REQUIRING QUALITY PLAN			DOC. NO. :	CS-9585-001-2	
					AND SUB-SUPPLIER APPROVAL			REV. NO. :	0	
	Package:	EPC (SG SCOPE)						DATE:	05.04.2017	
	Supplier:	BHEL				BHEL, HYDERABAD				
	Contract No.:	CS-9585-001-2			SUB-SYST	MILLS				
S.No.	ITEM	QP/Insp. Cat.	QP No.	QP Sub-Schedule	QP approval schedule	Proposed sub-supplier	Place	Suppliers approval status/ category	Sub-supplier Details submission schedule	Remarks
LEGENDS :	AS PER BHEL TRICHY VENDOR LIST									
NOTES : AS GIVEN IN BHEL TRICHY VENDOR LIST										

Bharat Heavy Electricals Limited ★ PS-MKTG Delhi

★ Patratu Vidyut Utpadan Nigam Limited ★ Distt-Ramgarh(Jharkhand) C & M Deptt.

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	Project:	PATRATU	3x800	MW	LIST OF ITEMS REQUIRING QUALITY PLAN			DOC. NO.:	CS-9585-001-2	
					AND SUB-SUPPLIER APPROVAL			REV. NO. :	0	
	Package:	EPC						DATE:	04.04.2017	
	Supplier:	BHEL				BHEL RANIPET				
	Contract No.:	CS-9585-001-2			SUB-SYST	BOILER AUXILIARIES & ESP				
S.No.	ITEM	QP/Insp. Cat.	QP No.	QP Sub-Schedule	QP approval schedule	Proposed sub-supplier	Place	Suppliers approval status/ category	Sub-supplier Details submission schedule	Remarks
1	APH	I				REFER SUB QR LIST				VENDORS FOR MAIN STATIC AND ROTATING COMPONENTS SHALL BE TIED UP IN EXECUTION PLAN
2	STEAM COIL AIR PRE HEATER	III				MAIN CONTRACTOR'S APPROVED SOURCES				
3	AIR RECEIVER TANK	III				MAIN CONTRACTOR'S APPROVED SOURCES				
4	FD FAN	I				REFER SUB QR LIST				VENDORS FOR MAIN STATIC, ROTATING COMPONENTS, BLADES SHALL BE TIED UP IN EXECUTION PLAN
5	PA FAN	I				REFER SUB QR LIST				VENDORS FOR MAIN STATIC, ROTATING COMPONENTS, BLADES SHALL BE TIED UP IN EXECUTION PLAN
6	ID FAN	I				REFER SUB QR LIST				VENDORS FOR MAIN STATIC, ROTATING COMPONENTS, BLADES SHALL BE TIED UP IN EXECUTION PLAN
7	SEAL AIR FAN	I				CB DOCTOR & CO.	AHMEDABAD	A		
		I				BHEL	RANIPET	A		
		I				TLT INDIA	GUJARAT	A		
		I				ADREW YULE	KOLKATA	A		
		I				PATEL AIR TEMP	AHMEDABAD	A		
		I				ACCEL	AHMEDABAD	A		
		I				NADI TECHNOLOGIES PVT LTD	CHENNAI	DR		
		I				VACUNAIR ENGG. CO. PVT LTD	AHMEDABAD	DR		

Bharat Heavy Electricals Limited ★ PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited ★ Dist.-Ramgarh (Jharkhand) C & M Deptt.

4/4/17.
R. ARUMACHALAM
BHEL (Ranipet

	Project:	PATRATU	3x800	MW	LIST OF ITEMS REQUIRING QUALITY PLAN			DOC. NO.:	CS-9585-001-2	
					AND SUB-SUPPLIER APPROVAL			REV. NO.:	0	
	Package:	EPC						DATE:	04.04.2017	
	Supplier:	BHEL				BHEL RANIPET				
	Contract No.:	CS-9585-001-2			SUB-SYST	BOILER AUXILIARIES & ESP				

S.No.	ITEM	QP/Insp. Cat.	QP No.	QP Sub-Schedule	QP approval schedule	Proposed sub-supplier	Place	Suppliers approval status/ category	Sub-supplier Details submission schedule	Remarks
8	LUB OIL SYSTEM FOR FANS(ID,FD & PA)	I				PSI ENGG.	CHENNAI	A		
		I				CENLUB	FARIDABAD	A		
		I				LINCOLN HELIOS	BANGALORE	A		
		I				BHEL	RANIPET	A		
		I				SOUTHERN LUBRICATION	BANGALORE	A		
		I				TA HYDRAULICS	HYDERABAD	A		
		I				SPRAYING SYSTEM INDIA PVT. LTD.	BANGALORE	DR		
9	RIGIFLEX COUPLING FOR AXIAL FANS	III				MAIN CONTRACTOR'S APPROVED SOURCES				
10	COOLER FOR FAN LOS	III				MAIN CONTRACTOR'S APPROVED SOURCES				
11	SCREW PUMP FOR LOS	III				LEISSTRITZ	GERMANY	A		
		III				ALEKTON	CHENNAI	A		
		III				KRAL	AUSTRIA	A		
		III				TUSHACO(DELTA)	DAMAN	A		SUB. TO CONDITIONS
		III				DELTA PD PUMPS PVT. LTD.	MUMBAI	DR		
		III				UT PUMPS	FARIDABAD	DR		
12	EMITTING ELECTRODES FOR ESP	I				SIVA SPRINGS	MADURAI	A		

Bharat Heavy Electricals Limited PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited C & M Deptt.

4/4/17

	Project:	PATRATU	3x800	MW	LIST OF ITEMS REQUIRING QUALITY PLAN			DOC. NO. :	CS-9585-001-2	
					AND SUB-SUPPLIER APPROVAL			REV. NO. :	0	
	Package:	EPC						DATE:	04.04.2017	
	Supplier:	BHEL				BHEL RANIPET				
	Contract No.:	CS-9585-001-2			SUB-SYST	BOILER AUXILIARIES & ESP				

S.No.	ITEM	QP/Insp. Cat.	QP No.	QP Sub-Schedule	QP approval schedule	Proposed sub-supplier	Place	Suppliers approval status/ category	Sub-supplier Details submission schedule	Remarks
		I				VENKATESWARA STEEL & SPRINGS(INDIA) PVT. LTD.	COIMBATORE	A		
		I				NAGAPPASPRINGS	RANIPET	A		
		I				KWALITY COILS	MADURAI	A		
		I				BEST COILS	RANIPET	A		
		I				VISHNU WIRE FORMS (P) LTD.	MADURAI	A		
13	COLLECTING ELECTRODE FOR ESP	I				BHEL	RANIPET	A		
14	ESP SUPPORT STRUCTURE (COLUMNS & ROOF BEAMS)	I				NTPC APPD SUBCONTRACTORS OF BHEL WITH BHEL MATERIAL				PROJECT SPECIFIC APPROVAL TO BE TAKEN BY BHEL FROM NTPC; VENDOR TO MEET TECH. SPEC. REQUIREMENTS FOR STR. FABRICATION
15	ESP SUPPORT STRUCTURE (COLUMNS & ROOF BEAMS MANUFACTURED FROM ROLLED SECTIONS), CASING	III				BHEL APPD SUBCONTRACTORS WITH BHEL MATERIAL				VENDOR TO MEET TECH. SPEC. REQUIREMENTS FOR STR. FABRICATION
16	COLLECTING/EMITTING ELECTRODE SUSPENSION ASSY.	III				BHEL APPD SUBCONTRACTORS WITH BHEL MATERIAL				

Bharat Heavy Electricals Limited ★ PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited ★ Distt. Ramgarh (Jharkhand) ★ C & M Deptt.

4/4/17

	Project:	PATRATU	3x800	MW	LIST OF ITEMS REQUIRING QUALITY PLAN			DOC. NO.:	CS-9585-001-2	
					AND SUB-SUPPLIER APPROVAL			REV. NO. :	0	
	Package:	EPC						DATE:	04.04.2017	
	Supplier:	BHEL				BHEL RANIPET				
	Contract No.:	CS-9585-001-2			SUB-SYST	BOILER AUXILIARIES & ESP				

S.No.	ITEM	QP/Insp. Cat.	QP No.	QP Sub-Schedule	QP approval schedule	Proposed sub-supplier	Place	Suppliers approval status/ category	Sub-supplier Details submission schedule	Remarks
17	CE AND DE RAPPING MECHANISM	III				MAIN CONTRACTOR'S APPROVED SOURCES				
18	ELECTRICALLY OPERATED HOIST FOR ESP- UPTO 3 TON CAPACITY	III				MAIN CONTRACTOR'S APPROVED SOURCES				
19	GATES	I				NTPC APPD SUBCONTRACTORS OF BHEL WITH BHEL MATERIAL	RANIPET	A		
20	DAMPERS	I				NTPC APPD SUBCONTRACTORS OF BHEL WITH BHEL MATERIAL	RANIPET	A		
21	LRB MATERIALS	I				MINWOOL ROCK FIBRES LTD.	RAJNANDAON, BHILAI	A		
		I				LAPINUS ROCKWOOL LTD.	GWALIOR	A		
		I				LLOYDS INSULATION, CHENNAI	BHILAI	A		
		I				PUNJSTAR INSULATION	BHILAI	A		
		I				GOENKA ROCK WOOL	RAIPUR	A		
		I				THERMOCARE ROCKWOOL PVT. LTD. ES. LTD.	RAJNANDAON	A		
		I				SHREERAM EQUITECH	DURG	A		
		I				MINWOOL ROCK FIBRES LTD.	RAJNANDAON, BHILAI	A		
		I				ROCKWOOL INDIA LTD.	MEDAK-AP	A		
		I				DHANBAD ROCKWOOL INSULATION PVT. LTD.	DHANBAD	A		
		I				MINSULATE MFG. CO,	JAMSHEDPUR	A		
		I				POLYBOND PROJECTS PVT. LTD.	DURG	A		

Bharat Heavy Electricals Limited PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited C & M Deptt. Dist-Ramgarh(Jharkhand)

	Project:	PATRATU	3x800	MW	LIST OF ITEMS REQUIRING QUALITY PLAN			DOC. NO.:	CS-9585-001-2	
					AND SUB-SUPPLIER APPROVAL			REV. NO. :	0	
	Package:	EPC						DATE:	04.04.2017	
	Supplier:	BHEL				BHEL RANIPET				
	Contract No.:	CS-9585-001-2			SUB-SYST	BOILER AUXILIARIES & ESP				
S.No.	ITEM	QP/Insp. Cat.	QP No.	QP Sub-Schedule	QP approval schedule	Proposed sub-supplier	Place	Suppliers approval status/ category	Sub-supplier Details submission schedule	Remarks
		I				HI-TECH ROCK FIBRE LTD.	RAJNANDGOAN	A		
		I				ROCKWOOL INDUSTRIES	BHILAI	A		
22	VIS FOR FANS	I				GERB	BANGALORE	A		
NOTE 1:	VENDORS UNDER A(ACCEPTED CATEGORY) ARE APPROVED WITH OR WITHOUT CONDITIONS IN PAST. SIMILAR CONDITIONS AS THE CASE MAY BE FOR THE VENDORS SHALL BE APPLICABLE FOR THIS PROJECT AND TIED UP IN THE QUALITY.									
NOTE 2:	VENDORS UNDER DR (DETAILS REQUIRED) CATEGORY SHALL BE REQUIRED TO SUBMIT THE DETAILS IN NTPC QUESTIONNAIRE.									

Bharat Heavy Electricals Limited PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited C & M Deptt. Distt-Ramgarh(Jharkhand)

4.4.17

	Project:	PATRATU	3x800	MW	LIST OF ITEMS REQUIRING QUALITY PLAN		DOC. NO.:	CS-9585-001-2	
					AND SUB-SUPPLIER APPROVAL		REV. NO. :	0	
	Package:	Steam Generator Island Package					DATE:	05.04.2017	
	Supplier:	BHEL							
	Contract No.:	CS-9585-001-2			SUB-SYST	SG & AUX.-FQP & ERECTION AGENCIES&ESP ERECTION AGENCIES			

S.No.	ITEM	QP/Insp. Cat.	QP No.	QP Sub-Schedule	QP approval schedule	Proposed sub-supplier	Place	Suppliers approval status/ category	Sub-supplier Details submission schedule	Remarks
1	BOILER & AUX.(PRESSURE PARTS, STRUCTURES,ROTATING EQUIPMENT)	I				DOWEL ERECTORS PVT. LTD.	CHENNAI	A		NOTE-1
		I				POWER MECH PROJECTS PVT. LTD.	VIJAYWADA	A		NOTE-1
		I				BRIDGE & ROOF	KOLKATA	A		NOTE-1
		I				KARPARA PROJECTS ENGG. PVT. LTD.	SURAT	A		NOTE-1
		I				IOTEP	MUMBAI	A		NOTE-1
		I				SUNIL HI-TECH ENGG.	NAGPUR	A		NOTE-1
		I				TATA PROJECTS LIMITED	HYDERABAD	A		NOTE-1
		I				TEXCEL ENGINEERS	CHENNAI	A		NOTE-1
		I				PCP INTERNATIONAL LTD.	CHANDIGARH	A		NOTE-1
		I				INDWELL CONSTN. LTD.	VIJAYWADA	A		NOTE-1
		I				EDAC ENGG. LTD.	CHENNAI	A		NOTE-1
		I				LARSEN & TUBRO LTD.	MUMBAI	A		NOTE-1
		I				BHAWANI ERECTORS	KARUNAGAPALLY	A		NOTE-1
		I				ESSAR PROJECTS (I) LTD.	MUMBAI	A		NOTE-1
		I				GOLDEN EDGE ENGG. PVT. LTD.	NEW DELHI	A		NOTE-1
		I				BROTHER ENGINEER	CENNAI	DR		NOTE-1
		I				ICS ENGG.	CHENNAI	DR		NOTE-1
						POWER MAX	KOLKATA	DR		NOTE-1
						SWAMINA INTERNATIONALS PVT LTD.	NEW DELHI	DR		NOTE-1
2	POWER CYCLE PIPING	I				INDWELL CONSTR LTD.	VIJAYWADA	A		NOTE-1

Bharat Heavy Electricals Limited PS-MKTG Delhi

Bharat Urjidyut Utpadan Nigam Limited C & M Deptt. Distt-Ramgarh(Jharkhand)

G.V. Rao 12/04/17.

	Project:	PATRATU	3x800	MW	LIST OF ITEMS REQUIRING QUALITY PLAN			DOC. NO. :	CS-9585-001-2	
					AND SUB-SUPPLIER APPROVAL			REV. NO. :	0	
	Package:	Steam Generator Island Package						DATE:	05.04.2017	
	Supplier:	BHEL								
	Contract No.:	CS-9585-001-2			SUB-SYST	SG & AUX.-FQP & ERECTION AGENCIES&ESP ERECTION AGENCIES				

S.No.	ITEM	QP/Insp. Cat.	QP No.	QP Sub-Schedule	QP approval schedule	Proposed sub-supplier	Place	Suppliers approval status/ category	Sub-supplier Details submission schedule	Remarks
		I				POWER MECH PROJECTS PVT. LTD	VIJAYWADA	A		NOTE-1
		I				TEXCEL ENGINEERS	CHENNAI	A		NOTE-1
		I				BRIDGE & ROOF	KOLKATA	A		NOTE-1
		I				KARPARA PROJECTS ENGG. PVT. LTD.	SURAT	A		NOTE-1
		I				SUNIL HI-TECH ENGG.	NAGPUR	A		NOTE-1
		I				IOTEP	MUMBAI	A		NOTE-1
		I				PCP INTERNATIONAL LTD.	CHANDIGARH	A		NOTE-1
		I				LARSEN & TUBRO LTD.	MUMBAI	A		NOTE-1
		I				EDAC ENGG. LTD.	CHENNAI	A		NOTE-1
		I				TATA PROJECTS LTD.	HYDERABAD	A		NOTE-1
		I				BHAWANI ERECTORS	KERALA	A		NOTE-1
		I				U B ENGG.	PUNE	DR		NOTE-1
		I				DOWEL ERECTORS	CHENNAI	A		NOTE-1
		I				GOLDEN EDGE ENGG.	NEW DELHI	A		NOTE-1
3	LP PIPING	I				NOTE-2				
4	HT MOTORS	I				NOTE-2				
5	COMPRESSED AIR SYSTEM	I				NOTE-2				
6	MILL REJECT HANDLING SYSTEM	I				NOTE-2				
7	PASSENGER CUM GOODS ELEVATOR	I				NOTE-2				

Bharat Heavy Electricals Limited PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited C & M Deptt. Distt-Ramgarh (Jharkhand)

G.V. Rattesh 12/04/17

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	Project:	PATRATU	3x800	MW	LIST OF ITEMS REQUIRING FIELD QUALITY PLAN AND ERECTION SUBCONTRACTOR APPROVAL		DOC. NO.:	CS-9585-001-2	
							REV. NO.:	0	
	Package:	Steam Generator Island Package					DATE:	05.04.17	
	Supplier:	BHEL							
	Contractor No.:	CS-9585-001-2			SUB-SYSTEM	ESP ERECTION AGENCY			

S.No.	ITEM	QP/Insp. Cat.	QP No.	QP Sub-Schedule	QP approval schedule	Proposed sub-supplier	Place	Suppliers approval status/ category	Sub-supplier Details submission schedule	Remarks
1	ESP	I				BROTHERS ENGG. & ERECTORS	VIJAYAWADA	A		NOTE 1
		I				POWER MECH PROJECTS	VIJAYAWADA	A		NOTE 1
		I				BRIDGE & ROOF	KOLKATA	A		NOTE 1
		I				BHAVANI ERECTORS PVT. LTD.	KERLA	A		NOTE 1
		I				L&T LTD.	MUMBAI	A		NOTE 1
		I				PCP INTERNATIONAL LTD.	CHANDIGARH	A		NOTE 1
		I				SUNIL HI-TECH	NAGPUR	A		NOTE 1
		I				DOWEL ERECTORS PVT. LTD.	CHENNAI	A		NOTE 1
		I				INDWELL CONSTR. LTD.	VIJAYAWADA	A		NOTE 1
		I				KARPARA PROJECTS ENGG.	SURAT	A		NOTE 1
		I				TEXCEL ENGINEERS PVT. LTD.	CHENNAI	A		NOTE 1
		I				TATA PROJECTS LTD.	HYDERABAD	A		NOTE 1
		I				IOTEP	MUMBAI	A		NOTE 1
		I				EDAC	CHENNAI	A		NOTE 1
		I				ZILLION	NEW DELHI	A		NOTE 1
		I				GOLDEN EDGE ENGG. PVT.LTD.	DELHI	A		NOTE-1
						P E ERECTORS	KOLKATA	A		NOTE-1
		I				UB ENGG.	PUNE	DR		NOTE-1

EGENDS	
1	SYSTEM SUPPLIER / SUB-SUPPLIER APPROVAL STATUS CATEGORY (SHALL BE FILLED BY NTPC)
A -	For these items proposed vendor is acceptable to NTPC. To be indicated with letter "A" in the list alongwith the condition of approval, if any. The same conditions shall be applicable here as well.
DR -	For these items "Detailed required" for NTPC review. To be identified with letter "DR" in the list.
2	Notes
Note - 1	Additional vendors may be considered as per MOM provisioon, rganizational , financial & technical aspects will be taken care by BHELbefore award of the jobs to the sub contractors. Mobilisation of manpower, tools, tackles to suit the requirements of job schedule shall be tied up by BHEL in consultation with NTPC site before award for which the details of sub contractors shall be forwarded to respective GM I/C (NTPC-SITE). I. M/s BHEL to ensure that the requirements of NTPC regarding the deployment of erection Agency in connection with the work schedule for the subject project and package is met.
Note - 2	BHEL approved sub contractors for erection – would mean NTPC approval is not required
NOTE 3:	BHEL WILL FOLLOW THEIR STANDARD PROCEDURE, CORPORATE GUIDELINES AND SHALL COMPLY WITH CIRCULARS/INSTRUCTIONS ETC. ISSUED BY GOVT./RELEVANT STATUTORY BODIES WHILE TENDERING. HOWEVER FOR NEW VENDOR, BHEL SHALL TAKE APPROVAL FROM NTPC PRIOR TO ORDER PLACEMENT.

Bharat Heavy Electricals Limited ★ PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited ★ Distt-Ramgarh(Jharkhand) ★ C & M Deptt.

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G.V.Rajasekhar 12/04/17
(G.V.RAJASEKHAR)
/BHEL-PSNR)

	Project:	PATRATU	3X800	MW	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB-SUPPLIER APPROVAL			DOC. NO.:	CS-9585-001-2	
								REV. NO. :	0	
	Package:	EPC/SG						DATE:	12.05.2015	
	Supplier:	BHEL								
	Contract No.:	CS-9585-001-2			SUB-SYST	BHEL PIPING CENTRE, CHENNAI				
S.No.	ITEM	QP/Insp. Cat.	QP No.	QP Sub-Schedule	QP approval schedule	Proposed sub-supplier	Place	Suppliers approval status/ category	Sub-supplier Details submission schedule	Remarks
	NOTE: FABRICATION OFFLOADING SHALL BE AS PER AGREED LIST BETWEEN NTPC & BHEL									
1	AUX PRDS UNIT (INCLUDING CONTROL VALVE)	I								VENDORS TIED UP BHEL PEM VENDOR LIST
2	LIGHTLY BONDED WOOL MATTRESS CONVENTIONAL	I								VENDORS AS PER BHEL TRICHY BOILER LIST
3	CONVENTIONAL VALVES OTHER THAN BHEL	I								VENDORS AS PER BHEL TRICHY BOILER LIST
4	HANGERS & SUPPORTS WITH SPRING ARRANGEMENT(INCLUDING CLH/VLH)	I				PIPE SUPPORTS	UK	A		
		I				LISEGA	GERMANY, CHINA	A		Lisega, China approval conditions as per NTPC approval letter
		I				CARPENTER & PATTERSON	UK	A		
		I				MANNESMANN	GERMANY	A		
		I				SANWA TAKI	JAPAN	A		
		I				BROWICK	UK	A		
		I				GILLARDINI	ITALY	A		
		I				ITT	GERMANY	A		
		I				MH	SPAIN	A		

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(NITIN KUMAR) PS-M BHEL

	Project:	PATRATU	3X800	MW	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB-SUPPLIER APPROVAL			DOC. NO. :	CS-9585-001-2	
								REV. NO. :	0	
	Package:	EPC/SG						DATE:	12.05.2015	
	Supplier:	BHEL								
	Contract No.:	CS-9585-001-2			SUB-SYST	BHEL PIPING CENTRE, CHENNAI				

S.No.	ITEM	QP/Insp. Cat.	QP No.	QP Sub-Schedule	QP approval schedule	Proposed sub-supplier	Place	Suppliers approval status/ category	Sub-supplier Details submission schedule	Remarks
5	HANGERS & SUPPORTS (RIGID TYPE) WITHOUT SPRING ARRANGEMENT	III				MAIN CONTRACT APPROVED VENDORS				
6	PIPING FABRICATION-P91 MATERIAL	I				BHEL	TRICHY	A		
7	PIPING FABRICATION (IBR)	I				BHEL	CHENNAI	A		
8	PIPING FABRICATION (NON-IBR)	I				BHEL	CHENNAI	A		
9	BUILT UP BEAMS/FABRICATED BEAMS-AUTO WELDING	I				AS PER BHEL-TRICHY LIST				
10	CONSTANT/VARABLE LOAD HANGERS (BHEL MAKE)	I				BHEL	TRICHY	A		
11	TANKS AND VESSELS	I				BHEL CHENNAI	CHENNAI	A		
12	NON IBR PIPING / LP PIPING - PR. BELOW 10	III				BHEL APPROVED SOURCES				
13	STRUCTURE FABRICATION (ROLLED SECTION)	III				BHEL	CHENNAI	A		
14	DEAD WEIGHT CLH	III				BHEL	CHENNAI	A		
15	SHOP MANUFACTURED FITTINGS OF 91 GR.MATL.	I				BHEL	TRICHY	A		
16	FLOW ELEMENTS - OTHER THAN BHEL	I								Refer BHEL, Trichy C&I list for Sub-vendors
17	AIR TRAPS	III								BHEL Approved Vendors
18	BEARINGS	III								BHEL Approved Vendors

Bharat Heavy Electricals Limited PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited Distt-Ramgarh(Jharkhand) C & M Deptt.

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	Project:	PATRATU	3X800	MW	LIST OF ITEMS REQUIRING QUALITY PLAN			DOC. NO.:	CS-9585-001-2	
					AND SUB-SUPPLIER APPROVAL			REV. NO.:	0	
	Package:	EPC/SG						DATE:	12.05.2015	
	Supplier:	BHEL								
	Contract No.:	CS-9585-001-2			SUB-SYST	BHEL PIPING CENTRE, CHENNAI				
S.No.	ITEM	QP/Insp. Cat.	QP No.	QP Sub-Schedule	QP approval schedule	Proposed sub-supplier	Place	Suppliers approval status/ category	Sub-supplier Details submission schedule	Remarks
19	CHEMICALDOSING TANK (HP/LP)	III								BHEL Approved Vendors
20	COOLING WATER VALVES	III								BHEL Approved Vendors
21	FITTINGS-P91/92	I				VENDORS AS PER BHEL TRICHY VENDORS LIST				
22	FITTIINGS (CS,SS & AS UPTO GR22	II								PROCUREMENT FROM BHEL APPROVED VENDORS
23	FIXING COMPONENTS, SEALING COMPOUND FOR INISULATION	III								BHEL Approved Vendors
24	HANGER CONNECT COMP. (CLEVIS, EYENUT, TURNBUCKLE, TIEROD, WELD ON BRACKET ETC	III								BHEL Approved Vendors
25	INSULATION CLAMPS	III								BHEL Approved Vendors
26	LEVEL GAUGE GLASS (FOR CBD, IBD, FLASH CHEM. DOSING TANKS	III								BHEL Approved Vendors
27	PLUG & BALL VALVES (COOLING WATER AND AIR LINES)	III								BHEL Approved Vendors
28	SIGHT FLOW INDICATORS	III								BHEL Approved Vendors
29	SNUBERS (IMPORTED)	III								BHEL Approved Vendors
30	STEAM TRAPS	III								BHEL Approved Vendors

Bharat Heavy Electricals Limited * PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited * Distt-Ramgarh(Jharkhand) C & M Deptt.

	Project:	PATRATU	3X800	MW	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB-SUPPLIER APPROVAL			DOC. NO.:	CS-9585-001-2	
								REV. NO.:	0	
	Package:	EPC/SG						DATE:	12.05.2015	
	Supplier:	BHEL								
	Contract No.:	CS-9585-001-2			SUB-SYST	BHEL PIPING CENTRE, CHENNAI				

S.No.	ITEM	QP/Insp. Cat.	QP No.	QP Sub-Schedule	QP approval schedule	Proposed sub-supplier	Place	Suppliers approval status/ category	Sub-supplier Details submission schedule	Remarks
31	STEAM TRAPS THERMODYNAMIC TYPE	III								BHEL Approved Vendors
32	STRAINERS	III								BHEL Approved Vendors
33	COOLING WATER PUMP	III				SULZER INDIA	NAVI MUMBAI	A		
		III				KSB	PUNE	A		
		III				KIRLOSKAR	WADI	A		
		III				MATHER AND PLATT	PUNE	A		
		III				BECON WEIR	CHENNAI	A		
		III				SAM PUMPS	COIMBATORE	A		
		III				JYOTI	BARODA	A		
34	LP CHEMICAL DOSING SYSTEM	II				Power Piping	Trichy	A		
		II				V.K.Pumps	Mumbai	A		
		II				Milton Roy	Chennai	A		
		II				Techno Consultants	Mumbai	A		
		II				Positive Metering System	Nasik	A		
		II				PSI Engg System	Chennai	A		
		II				Matz Pump	Ahmedabad	DR		
		II				DEE DEVELOPMENT	HARYANA	DR		
35	LP CONDENSATE TRANSFER PUMP	I				ITT GOULD	USA	A		
		I				FLOWSERVE	USA	A		

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Patratu Vidyut Utpadan Nigam Limited C & M Dept. Distt-Ramgarh (Jharkhand)

	Project:	PATRATU	3X800	MW	LIST OF ITEMS REQUIRING QUALITY PLAN			DOC. NO.:	CS-9585-001-2	
					AND SUB-SUPPLIER APPROVAL			REV. NO. :	0	
	Package:	EPC/SG						DATE:	12.05.2015	
	Supplier:	BHEL								
	Contract No.:	CS-9585-001-2			SUB-SYST	BHEL PIPING CENTRE, CHENNAI				
S.No.	ITEM	QP/Insp. Cat.	QP No.	QP Sub-Schedule	QP approval schedule	Proposed sub-supplier	Place	Suppliers approval status/ category	Sub-supplier Details submission schedule	Remarks
						CLYDE PUMPS	GHAZIABAD	A		
		I				SULZER	NAVI MUMBAI	A		
36	BUTTERFLY VALVES(upto 1400NB-PN10 & upto 300NB-PN16)					R&D Multiple	Valsad	A		
						Fouress Engg.	Bangalore	A		
						Weir BDK	Hubli	A		UPTO1050NB PN-16
						IL	Palghat	A		
						Intervalve	Pune	A		
						KBL	Kondhapuri	A		
						PENTAIR	Kondhapuri	A		UPTO 900NB PN-16
						FLOSERVE	Coimbatore	A		
						L&T		DR		
37	BOILER FEED PUMP(AUX.BOILER)	III								BHEL Approved Vendors

NOTES :A - APPROVED, DR - DETAIL REQUIRED, N - NOTED. REFER TRICHY BOILER LIST FOR OTHER NOTES.

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Patratu Vidyut Utpadan Nigam Limited C & M Deptt. Distt-Ramgarh(Jharkhand)

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	Project:	PATRATU	3X800	MW	LIST OF ITEMS REQUIRING QUALITY PLAN			DOC. NO.:	CS-9585-001-2		
					AND SUB-SUPPLIER APPROVAL			REV. NO.	0		
	Package:	EPC/SG						DATE:	12.05.2015		
	Supplier:	BHEL									
	Contract No.:	CS-9585-001-2			SUB-SYSTE	PEM SCOPE					

S.No.	ITEM	QP/Insp. Cat.	QP No.	QP Sub Schedule	QP approval schedule	Proposed sub-supplier	Place	Sub-Suppliers approval status/ category	Sub-supplier Details submission schedule	SQP Status	Remarks
1	AUX PRDS UNIT (INCLUDING CONTROL VALVE)	I				INSTRUMENTATION LTD	PALGHAT	A			Steam conditioning valve from Hora Germany & Desuperheater from Copes Vulcan
		I				PARCOL	ITALY	A			
		I				HORA (HOLTER)	GERMANY	A			
		I				MIL	THRISSUR	A			WITH W&T GERMANY
		I				DAUME	GERMANY	A			
		I				CCI	SRICITY	DR			
		I				KOSO INDIA PVT. LTD.	NASIK	DR			

NOTES AND LEGEND AS PER BHEL TRICHY VENDOR LIST

Bharat Heavy Electricals Limited * PS-MKTG Delhi

(Nilesh Kamal)

* Patratu Vidyut Utpadan Nigam Limited * Distt-Ramgarh (Jharkhand) * C & M Deptt.

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NTPC	PROJECT : PATRATU PACKAGE : EPC (FGD) Package MAIN CONTRACTOR : M/s BHEL CONTRACT NO : CS-9585-001-2	LIST OF ITEMS REQUIRING QP APPROVAL & ACCEPTABLE VENDOR AS APPROVED BY	REF. NO : REVISION NO : 00 DATE : 16-05-17

No.	Major Equipment	QP Inspection Category	QP No.	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Place	SS Approval Status	SS Detail Sub. SCH	SS Approval SCH	Remark
1	Slurry re-circulation Pumps	I									Refer Sub.QR List
2	Oxidation Blowers	I									Refer Sub.QR List
3	Wet Limestone Grinding Mill	I									Refer Sub.QR List
4	Slurry Pumps	I									Refer Sub.QR List
5	Agitators	I									Refer Sub.QR List
6	Vacuum Belt Filters	I									Refer Sub.QR List
9	Bucket Elevator	I				Indiana Conveyors Pvt.Ltd.	Jejori, Pune	A			
						Bevcon Wayors Pvt.Ltd	HYDERABAD	DR			
10	Absorber Tank	I				BHEL	Ranipet	DR			
11	Atmospheric Tanks	III				Main Contractor approved sub contractor					
12	Structural Items(Columns,Beams & Bracings) Built up section .					BHEL	Ranipet	DR			
		I				Jindal	Ghaziabad	A			UP TO 350NB (Black & GI)
		III				TATA STEEL	Jamshedpur	A			UP TO 150 NB (Black & GI)
		III				SAIL	Rourkela	A			
		I				Surya Roshni	Bahadurgarh	A			UP TO 400NB (Black & GI)
		I				Welspan	Anjar	A			UP TO 400NB (Black)

Patratu Vidyut Utpadan Nigam Limited * Distt-Ramgarh(Jharkhand) * C & M Deptt.

Bharat Electricals Limited PS-MKTG Delhi

BHEL
(SASHI KUMAR)

NTPC	PROJECT : PATRATU	LIST OF ITEMS REQUIRING QP	REF. NO :
	PACKAGE : EPC (FGD) Package	APPROVAL & ACCEPTABLE	REVISION NO : 00
	MAIN CONTRACTOR : M/s BHEL	VENDOR AS APPROVED BY	DATE : 15-05-17
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No.	QP Sub missi on SCH	QP Approval SCH	Proposed Sub Supplier	Place	SS Approval Status	SS Detail Sub. SCH	SS Approval SCH	Remark
13	MS Pipes (ERW)	I				MSL	Raigad	A			200 to 500 NB (Black)
		I				Indus Tube	G. B. Nagar	A			UP TO 300 NB (Black & GI)
		I				Jindal Industries	Hissar	A			UP TO 300 NB (Black & GI)
		I				AFL Apollo	Sikandrabad	A			UP TO 300NB (Black)
		I				Dadu Pipes	Sikandrabad	A			UP TO 300 NB (Black)
		I				ISMT	Ahmedabad	A			
14	Spiral Welded upto [illegible]	I				Ratnamani	Anjar / Chatral	A			
						JCO Gas Pipes	Chindwara	A			
						SAIL	Raurkella	A			
						Surya Global	Kutch	A			
15	LRB Insulation	I				Lloyd Insulation	Chennai	A			
		I				Rockwool Industries	Bhilai / Medak	A			
		I				Minwool Rock Fibres Ltd.	Rajnandgaon	A			
		I				Lapinus Rockwool Ltd.	Gwalior	A			
		I				Punjstar(PIFCO)	Bhilai	A			
		I				Goenka Rockwool	Raipur	A			
		I				Rockwool India Ltd.	Medak-AP	A			
		I				Thermocare Rockwool Pvt.Ltd.	Rajnandgaon	A			
		I				Minsulate Mfg.Co	Jamshedpur	A			
		I				Dhanbad Rockwool	Dhanbad	A			
		I				Hitech Rockwool Fibre	Rajnandgaon	A			
		I				Roxul RockwoolInsulation	Dahej(Bharuch)	A			
16	Gates & Dampers	I				Indra Damper	Ranipet	A			
		I				Bachmann	Faridabad	A			
		I				Fouress	Bengaluru	A			
		I				BHEL	Ranipet	A			
		I				Clyde Burgmann Bachmann	USA	A			
17	Valves for FGD application#	I				BHEL	Trichy	A		As per approval (Type/Class/Rating & Material	
		I				Bankim Valves	Howrah	A		CI Gate/Check/Globe upto600NB,PN16.	
		I				H.Sarkar & Co	Howrah	A		CI Gate/Check/Globe upto 700NB,PN16	

Patratu Vidyut Utpadan Nigam Limited, Distt-Ramgarh(Jharkhand) C & M Deptt.

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BHEL

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NTPC	PROJECT : PATRATU	LIST OF ITEMS REQUIRING QP	REF. NO :
	PACKAGE : EPC (FGD) Package	APPROVAL & ACCEPTABLE	REVISION NO : 00
	MAIN CONTRACTOR : M/s BHEL	VENDOR AS APPROVED BY	DATE : 16-05-17
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No.	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Place	SS Approval Status	SS Detail Sub. SCH	SS Approval SCH	Remark
		I				Leader	Jalandhar	A		CI Gate/Check/Globe upto 300NB,PN10.SS upto 300NB & CS upto 300NB,Class 150, GM Valve upto 150NB	
		I				Weir BDK	Hubli	A		Gate/Globe/Check Valves upto300NB,Class300 for SS,CI&CS	
		I				KBL	Kondapuri	A		Valve upto	
		I				A.V Valves	Agra	A		CI Gate/Globe/Check Valves upto 300NB,PN10	
		I				Tyco Valves / Pentair Valves	Halol(Gujarat)	A		For CS,CI&SS Butterfly Valve	
		I				L&T	Coimbatore	A		CS&AS-Low Pr. Valves-Gate/Globe/Check Valves upto 26",class600, High Pr. Upto20",2500class Forged Steel upto 1" 4500 class.	
		I				Weir BDK	Hubli	A		CS Ball Valves(upto 350NB-class150)	
		I				Leader	Jalandhar	A		Valve(upto350NB,class15	
		I				Leader	Jalandhar	A		Forged Steel(CS) upto300NB,class150.	
		I				Fouress Engineering	Thane,Aurangabad	A		Forged Steel(CS)upto 300NB,Class150)	
		I				Weir BDK	Hubli	A		Diaphgram Valves	
		I				Advance Valve	Noida	A		CI Butterfly valves 1400 NB, PN 10; 300 NB PN16	
		I				Fouress Engineering	Bangalore	A		Knife Gate valves	
		I				Micro Finish	Hubli	A		Ball Valve 350 NB Class 150, upto 50 NB Class 800	
		II				Inter Valves	Pune	A		CI Butterfly valves 1400 NB, PN 10; 300 NB PN16	
		II				Xomos Sanmar	Pune / Chennai	A		Forged Steel Gate globe check valve upto 50 NB Class 800	
		II				Dembla	Pune	A		CI Butterfly valves 1400 NB, PN 10; 300 NB PN16	

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Patratu Vidyut Utpadan Nigam Limited * Distt-Ramgarh(Jharkhand) C & M Deptt.

BHEL

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NTPC	PROJECT : PATRATU	LIST OF ITEMS REQUIRING QP	REF. NO :
	PACKAGE : EPC (FGD) Package	APPROVAL & ACCEPTABLE	REVISION NO : 00
	MAIN CONTRACTOR : M/s BHEL	VENDOR AS APPROVED BY	DATE : 16-05-17
	CONTRACT NO : CS-9588-001-2		

No.	Major Equipment	QP Inspection Category	QP No.	QP Sub mission SCH	QP Approval SCH	Proposed Sub Supplier	Place	SS Approval Status	SS Data II Sub. SCH	SS Approval SCH	Remark
		I				Hawa Engineers	Ahmedabad	A		Forged Steel Gate globe check valve upto 50 NB Class 800	
		I									
		I									
		I									
18	Flap Gate, R&P Gate,										
		I				TKII	Pune	A			
		I				Mining&Material Handling	Kolkata	A			
						United Technomac	Pune	A			
		I				MBE	Kumardhubi	A			
		I				Prepec	Howrah	A			
						HMTC	Kolkata	A			
		I				Elecon	VV Nagar	A			
		I				Indiana Conveyor	Jejori, Pune	A			
		I						DR			
		I						DR			
		I						DR			
		I				Kirloskar Brothers	Pune	A			
		I				Sam Turbo	Coimbatore	A			
		I				Mather & Platt	Pune	A			
19	Water Pumps(process water)	I				KSB	Pune	A			
		I				Weir Minerals	Bangalore	A			
		I				WPIL	Kolkata/Gaziabad	A			
		I				Kishore	Pune	A			
		I				Flow More	Ghaziabad	A			
20	Metallic Expansion Joints	I				Lonestar Industries	Chennai	A			
		I				Mechwell	Nasik	A			
		I				BHEL	Ranipet	A			
		I				Keld Ellenloff	Chennai	A			
		I				Eagle Burgmann	Chennai / Denmark	A			
21	Non-Metallic Expansion Joints for Ducts	I				HKR	Kolcata	A			
		I				Safetech	Delhi	A			
		I				Bachmann Industries(India) Ltd.	New Delhi	DR			
		I				Elastomeric Engineers	Salem	DR			
		I				Urja Products Pvt.Ltd.	Ahmedabad	DR			

Bharat Heavy Electricals Limited PS-MKTG Delhi

Deptt.

BHEL

NTPC	PROJECT : PATRATU	LIST OF ITEMS REQUIRING QP	REF. NO :
	PACKAGE : EPC (FGD) Package	APPROVAL & ACCEPTABLE	REVISION NO : 00
	MAIN CONTRACTOR : M/s BHEL	VENDOR AS APPROVED BY	DATE : 16-05-17
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No.	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Place	SS Approval Status	SS Detail Sub. SCH	SS Approval SCH	Remark
22	Electrical Hoist	I				Hercules Hoist Ltd.	Mumbai	A		Electric Hoist upto 15MT	CAT - III upto 5 T capacity Hoist,
		I				Reva Industries	Faridabad	A		Upto 40MT	
		I				Consolidated Hoist	Satara / Pune	A		EOT Cranes upto 40MT and Hoists above 15MT	
		I				Lifting Equipment and Accessories	New Delhi	A		Hoists upto 5MT	
		I				Grip Engineering Pvt.Ltd	Faridabad	A		EOT upto 5MT & Hoist upto 20MT	
		I				Brady & Morris	Ahmedabad	A		Upto 10 Tons	
		I				Consolidated Hoist	Pune	A		Upto 35 Tons at Satara & Upto 15 Tons at Pune works	
		I				Tuobro Furguson India Pvt. Ltd	Kolkata	A		Upto 5 Tons	
		I				Grip Engineers	Faridabad	A		Upto 20 Tons	
		I				Tractel Tirfor India Pvt. Ltd	Palwal	A		Upto 15 Tons	
		I				Universal Hoist Fabrik	Thane	A		Upto 20 Tons	
		I				Mangla Hoist	Greater Noida	A		Upto 10 Tons	
		I				Reva Industries	Faridabad	A		Upto 25 Tons	
		I				Eddy Cranes	Pune	A		Upto 14 Tons	
		I				Alpha Services	Bhiwadi	A		Upto 15 Tons	
		I				Century Crane Engineers	Ballabhgarh	A		Upto 25 Tons	
		I				Grip Engineers	Hyderabad	A		Upto 40 Tons	
		I				Anmsel MHE Pvt.Ltd.	Bangalore	A		Hoist upto 15MT,EOT upto 10MT	
		I				Century Crane Engineers	Ballabhgarh	A		Upto 15 Tons	
		I				Tractel Tirfor India Pvt. Ltd	Kalyani	A		Upto 20 Tons	

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BHEL

NTPC	PROJECT : PATRATU	LIST OF ITEMS REQUIRING QP	REF. NO :
	PACKAGE : EPC (FGD) Package	APPROVAL & ACCEPTABLE	REVISION NO : 00
	MAIN CONTRACTOR : M/s BHEL	VENDOR AS APPROVED BY	DATE : 16-05-17
	CONTRACT NO : CS-5585-001-2		

No.	Major Equipment	QP Inspection Category	QP No.	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Place	SS Approval Status	SS Detail Sub. SCH	SS Approval SCH	Remark
23	Hydro Cyclone	I				FL Smidth	Chennai	DR			
		I				Weir Minerals	Bangalore	A			
		I				Multo Tech	S.Africa	A			
		I				McNally Bharat	Bangalore	DR			
24	Rubber Lining of Pipes	I				Jasmino Polymertech	Taloja	A			
		I				CORI Engineers	Chennai	A			
		I				Western Rubber	Mumbai	A			
		I				Elastomer Lining	Ambernath	A			
		I				Emkay Rubber	Mumbai	A			
		I				Rishi	Bahalgarh	A			
		I				Poly Rubber	Mumbai	A			
		I				Temsec Rubber	Kolkata	A			
		I				Presidency Rubber	Howrah	A			
		I				Arul Rubber Pvt.Ltd	Hosur	A			
		I				Industrial Moulders	Vadodara	A			
		I				MILL Industries	Chennai	DR			
		I				Lebracs rubber	Pondicherry	DR			
25	FRP PIPE with fittings	III				Main contractor approved source		A		upto 3"	
26	Rubber Lining for Tank and absorber	III				MIL Industries	Chennai	A			
		III				TIP TOP	Germany	A			
		III				Steatuer	Germany	A			
		III				Arul Rubber	Hosur	A			
		III				Temsec Rubber	Kolkata	A			
						Lebracs Rubber	Pondicherry	DR			
						CORI Engineers	Chennai	DR			
27	Ventillation Fans	I				Patel Air	Ahmedabad	A			
		I				Marathan Electric	Kolkata	A			
		I				Howden	Kolkata / Chennai	A			
		I				SK System	Sonepat	A			
		I				Andrew Yule	Kolkata	A			
		I									

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Patratu Vidyut Utpadan Nigam Limited ★ Distt-Ramgarh(Jharkhand) ★ C & M Deptt.

BHEL

NTPC	PROJECT : PATRATU	LIST OF ITEMS REQUIRING QP	REF. NO :
	PACKAGE : EPC (FGD) Package	APPROVAL & ACCEPTABLE	REVISION NO : 00
	MAIN CONTRACTOR : M/s BHEL	VENDOR AS APPROVED BY	DATE : 15-05-17
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No.	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Place	SS Approval Status	SS Detail Sub. SCH	SS Approval SCH	Remark
28	Air receiver	I				Abacus Heat Transfer	Faridabad	A			
						KBL	Kondhapuri	A			
						Diamond Fabricators	Pune	A			
						Integrated Engineers	Mumbai	A			
						United Engineering Works	Nasik	A			
						Parkaire	Delhi	A			
						Temasmo Vesselex	Noida	A			
						GEM	Coimbatore	A			
						Vee Sons	Trichy	DR			
						Patel Air temp Ltd	Ahmedabad	DR			
						G B Industries	Trichy	DR			
						Par Energy Infra Pvt Ltd	Hyderabad	DR			
						Janta Engineering & Company	Faridabad	DR			
						Sri Rang Indsutries	Coimbatore	DR			
						C Doctor	Ahmedabad	DR			
29	Structual Steel Rolled /Plate Sections(CS)	$				SAIL		A			
		$				Ispat Industries		A			
		$				Lloyeds Steel		A			
		$				JSW		A			
		$				RINL		A			
30	Structural Steel – Pipes IS 1161	III				Main Contractor approved sources					
31	S S plates	$				JSL Stainless	Hisar	A			Upto 20 mm thick
		$				Industeel Loire	France	A			Liner SS 304
		$				Industeel Belgium	Belgium	A			GR -304,309,310,316
		$				Columbus Steel (Acrinox)	South Africa	A			GR -304,309,310,316
		$				SAIL	Bhilai/Salem	A			GR -304,309,310,316

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Utpadan Mukhyalaya Patratu Vidyut Utpadan Nigam Limited ★ Distt-Ramgarh(Jharkhand) ★ C&M Deptt.

BHEL

NTPC	PROJECT : PATRATU	LIST OF ITEMS REQUIRING QP	REF. NO :
	PACKAGE : EPC (FGD) Package	APPROVAL & ACCEPTABLE	REVISION NO : 00
	MAIN CONTRACTOR : M/s BHEL	VENDOR AS APPROVED BY	DATE : 16-05-17
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No.	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Place	SS Approval Status	SS Detail Sub. SCH	SS Approval SCH	Remark
32	Insulation Cladding	III				Nalco	India	A			
		III				Hindalco	India	A			
		III				Jindal	India	A			

LEGENDS

SYSTEM SUPPLIER/SUB-SUPPLIER APPROVAL STATUS CATEGORY (SHALL BE FILLED BY NTPC)

A – For these items proposed vendor is acceptable to NTPC. To be indicated with letter "A" in the list alongwith the condition of approval, if any.

DR – For these items "Detailed required" for NTPC review. To be identified with letter "DR" in the list.

* For the items not appearing in the preaward list, bidder and NTPC will mutually discussed in future.

QP/INSPN CATEGORY:

CAT-I : For these items the Quality Plans are approved by NTPC and the final acceptance will be on physical inspection witness by NTPC.

CAT-II : For these items the Quality Plans approved by NTPC. However no physical inspection shall be done by NTPC. The final acceptance by NTPC shall be on the basis review of documents as per approved QP.

CAT-III : For these items Main Supplier approves the Quality Plans. The final acceptance by NTPC shall be on the basis certificate of conformance by the main supplier.

UNITS/ WORKS : Place of manufacturing Place of Main Supplier of multi units/works.

* - Engg. clearance is also required being a Sub-QP.$- Review of Mill TC for RAW Material to be done by NTPC and shall be included in the QP of corresponding equipment.

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BHEL

NTPC	PROJECT: PATRATU 3X800 MW		LIST OF ITEMS REQUIRING QUALITY PLAN AND				REF NO. :
	PACKAGE: TG		SUBCONTRACTOR APPROVAL SUB SYSTEM: ST& AUX				REV NO.:
	CONTRACTOR: BHEL HARIDWAR CONTRACT NO.:						DATE: 05.04.2017

Sl No.	Item	QP Insp. Cat.	NTPC QP No. QVE-Q	Vendor/ Manufacturer Name	Place	SC_AP PL_ST ATUS	Remarks
1	HP OUTER CASING CASTING (EXHAUST)	I	QVM-Q-	JAPAN CASTING AND FORGING	JAPAN	A	NO SEPARATE VENDOR QP (ALREADY COVERED IN NTPC APPROVED BHEL MQP)
				THE JAPAN STEEL WORKS LTD.	JAPAN	A	
				LITOSTROJ STEEL LTD.	SLOWENIA	DR	
				STAR WIRE (INDIA) LTD.	INDIA	DR	
				ACCIAIERIA FONDERIA CIVIDALE	ITALY	A	
				VOESTALPINE GIESSEREI LINZ	AUSTRIA	A	
				SANDE STAHLGUSS GMBH	GERMANY	A	
				CFFP, BHEL	Haridwar	A	
				HANWA CO. LTD. (MANUFACTURER: UBE STEELS, JAPAN)	JAPAN	DR	
				LUCCHINI RS S.P.A.	ITALY	DR	
2	HP OUTER CASING CASTING (INLET)	I	QVM-Q-	ACCIAIERIA FONDERIA CIVIDALE	ITALY	A*	NO SEPARATE VENDOR QP (ALREADY COVERED IN NTPC APPROVED BHEL MQP) A* as per approval conditions
				THE JAPAN STEEL WORKS LTD.	JAPAN	A	
				JAPAN CASTING AND FORGING	JAPAN	A	
				VOESTALPINE GIESSEREI LINZ	AUSTRIA	A	
				CFFP, BHEL	Haridwar	DR	
3	EXHAUST HP OUTER CASING M/C	I	QVM-Q-	HEEP	Hardwar	A	
4	INLET HP OUTER CASING M/C			Rossi And Duso	Italy	A	
				MCE (New name BILFINGER MASCHINENBAU GMBH)	Austria	A	
				Bruno Presezzi	Italy	A	
				Nugo Romano	Italy	A	
5	HP INNER CASING CASTING	I	QVM-Q-	VOESTALPINE GIESSEREI LINZ	AUSTRIA	A	NO SEPARATE VENDOR QP (ALREADY COVERED IN NTPC APPROVED BHEL MQP) A* :Approved for wt. upto 20.5T
				ACCIAIERIA FONDERIA CIVIDALE	ITALY	A*	
				THE JAPAN STEEL WORKS LTD.	JAPAN	A	
				JAPAN CASTING AND FORGING	JAPAN	A	
				HANWA CO. LTD. (MANUFACTURER: UBE STEELS, JAPAN)	JAPAN	DR	
				SANDE STAHLGUSS GMBH	GERMANY	A*	
				SIEMENS AG	GERMANY	DR	
				ISGEC HEAVY ENGINEERING LTD	MUZZAFANAGAR	DR	
				LITOSTROJ STEEL LTD.	SLOVENIA	DR	
				STAR WIRE (INDIA) LTD.	Ballabhgarh	DR	
				CFFP, BHEL	Haridwar	A	
6	HP INNER CASING M/C	I	QVM-Q-	HEEP, BHEL	Hardwar	A	

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BHEL/ Haridwar

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				Rossl And Duso	Italy	A	
				MCE (New name BILFINGER MASCHINENBAU GMBH)	Austria	A	
				Bruno Presezzi	Italy	A	
				Nugo Romano	Italy	A	
7	HP TURBINE SHAFT FORGING 9-10% Cr	II	QVM-Q-	SAARSCHMIEDE GMBH	Germany	A	NO SEPARATE VENDOR QP (ALREADY COVERED IN NTPC APPROVED BHEL MQP)
				SCHMIEDEWERKE GRODITZ GMBH	Germany	DR	
				JAPAN CASTING AND FORGING	Japan	A	
				THE JAPAN STEEL WORKS LTD.	Japan	A	
				SDF, Terni	ITALY	A	
				BOHLER EDELSTAHL GMBH & CO. KG	AUSTRIA	DR	
				UMP TRADING S.A. (SUPPLY THRU ENERGOMASH, UKRAINE)	SWITZERLAND	DR	
8	HP TURBINE SHAFT M/C	I	QVM-Q-	- HEEP	Hardwar	A	
				- Rossl And Duso	Italy	A	
				-Bruno Presezzi	Italy	A	
				-Nugo Romano	Italy	A	
				-Siemens AG	Germany	A	
9	HP TURBINE ROTOR	I	QVM-Q-	HEEP	Haridwar	A	
10	HP STATIONARY & MOVING BLADES BAR STOCK	II	QVM-Q-	Böhler	Austria	A	NO SEPARATE VENDOR QP A*: ONLY FOR HW10687 & HW10786
				Walzwerke	Germany	A	
				Metal Ravne	Slovenia	A	
				Starwire	Ballabhgarh	A	
				Kalyani Carpenter	Pune	A*	
				BGH	GERMANY	A	
11	HP STATIONARY & MOVING BLADES (M/C)	II	QVM-Q-	Leistritz	Germany	A	
				EnergietechnikEinsal	Germany	A	
				Wuxi Turbine Blade	China	A	
				Officine Meccaniche Zema	Italy	A	
				Wiromet	Poland	A	
				CMSNC Di Menegazzi	Italy	DR	
				HEEP	Hardwar	A	
				Praewest Praezisionswerkstaett	Germany	DR	
				Siemens Ltd	India	DR	
				Euroflex Transmissions (India) Pvt. Ltd.	Hyderabad	DR	
12	ESV & CV CASING CASTING (HP VALVES) MAT 9-10% Cr		QVM-Q-	VOESTALPINE GIESSEREI LINZ	AUSTRIA	A	QP APPROVAL REQD. FOR STARWIRE, ISGEC and CFFP ONLY
				ACCIAIERIA FONDERIA CIVIDALE	ITALY	A	
				THE JAPAN STEEL WORKS LTD.	JAPAN	A	
				JAPAN CASTING AND FORGING	JAPAN	A	

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				HANWA CO. LTD. (MANUFACTURER: UBE STEELS, JAPAN)	JAPAN	DR	
				SANDE STAHLGUSS GMBH	GERMANY	A	
				LITOSTROJ STEEL LTD.	SLOWENUA	DR	
				STAR WIRE (INDIA) LTD.	BALLABHAGARH	A	
				CFFP, BHEL	Haridwar	A	
13	ESV & CV CASING (HP VALVES) M/C	I	QVM-Q-	-HEEP + NTPC approved sub-vendors	Haridwar	A	
				-Energy Machines	Ahemdabad	A	
14	CASTING FOR DIFFUSER / HP VALVE COVER / OVERLOAD VALVE CASING	II	QVM-Q-	INOSSMAN FONDERIE ACCIAIO MANI	ITALY	A	(QP APPROVAL REQD. FOR STARWIRE, ISGEC and CFFP ONLY)
				VOESTALPINE GIESSEREI TRAISEN	AUSTRIA	A	
				EMIRATES TECHNO CASTING FZE	SHARJAH	DR	
				LUCCHINI RS S.P.A.	ITALY	DR	
				THE JAPAN STEEL WORKS LTD.	JAPAN	A	
				JAPAN CASTING AND FORGING	JAPAN	A	
				SCHMOLZ + BICKENBACH GUSS GMBH	GERMANY	DR	
				STAHLGUSS SAAR GMBH	GERMANY	DR	
				GOODWIN STEEL CASTINGS LTD.	UK	DR	
				PEEKAY STEEL CASTINGS PVT LTD	CALICUT	DR	
				ISGEC HEAVY ENGINEERING LTD	MUZZAFANAGAR	A	
				LITOSTROJ STEEL LTD.	SLOWENIA	A	
				STAR WIRE (INDIA) LTD.	BALLABHAGARH	A	
				CFFP, BHEL	Haridwar	A	
15	HP VALVE ASSEMBLY	I	QVM-Q-	- HEEP	Hardwar	A	
16	HP JOINT BOLTS	I	QVM-Q-	- HEEP + NTPC approved sub-vendors #	Hardwar	A	#REFER NOTE 3
17	HP TURBINE ASSLY	I	QVM-Q-	- HEEP	Hardwar	A	
18	STEAM INLET / BREECH BLOCK / INLET CONNECTION / OVERLOAD CONNECTION / VALVE COVER / ALL RINGS & FORGINGS MAT 9-10%Cr	II	QVM-Q-	STARWIRE	Ballabhgarh	A	QP APPROVAL REQD. FOR CFFP ONLY AND FOR OTHERS BHEL APPROVED QAP TO BE FOLLOWED
				KISAAN STEEL	GHAZIABAD	DR	
				CHW FORGE	GHAZIABAD	A	
				GOODLUCK ENGINEERING	GHAZIABAD	DR	
				CFFP,BHEL	Haridwar	A	
				MIDHANI	HYDERABAD	A	
				BAY FORGE	Chennai	A	
				FORGITAL	ITALY	A	
				BOHLER	AUSTRIA	A	
19	FORGING FOR THREADED RING / SHAFT SEAL RING / RING / EXTRACTION INSERT / FLANGE MAT 1Cr 1Mo	II	QVM-Q-	MACKEIL ISPAT AND FORGINGS LTD	INDIA	DR	QP APPROVAL REQD. FOR CFFP ONLY AND FOR OTHERS BHEL APPROVED QAP TO BE FOLLOWED
				STAR WIRE (INDIA) LTD.	Ballabhgarh	A	
				KISAAN STEELS (PVT.) LTD.	GHAZIABAD	A	
				CHW FORGE (P) LTD	GHAZIABAD	A	
				GOOD LUCK ENGINEERING CO.	GHAZIABAD	A	
				GHAZIABAD FORGINGS PVT LTD	GHAZIABAD	DR	
				R. D. FORGE	GHAZIABAD	DR	
				CFFP,BHEL	Haridwar	A	

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				VISHNU FORGE	Bangalore	A	
				RING FORGINGS PVT LTD	Bangalore	DR	
				GHAZIABAD ISPAT UDYOG LTD.	GHAZIABAD	DR	
				VIKRANT FORGE LIMITED	KOLKATA	DR	
				BAY-FORGE LIMITED	Chennai	A	
				FORGITAL ITALY S.P.A.	ITALY	A	
20	IP OUTER CASING CASTING (NODULAR CASTING) BEARING PEDESTAL WITH COVER (NODULAR CASTING)	II	QVM-Q-	HANWA CO. LTD. (MANUFACTURER: UBE STEELS, JAPAN)	JAPAN	DR	NO SEPARATE VENDOR QP (ALREADY COVERED IN NTPC APPROVED BHEL MQP)
				FRIEDRICH WILHELM-HUETTE EISEN(BUDERGUSS)	GERMANY	A	
				ERGOCAST GUSS GMBH	GERMANY	A	
				SPEZIALGUSS WETZLAR GMBH	GERMANY	A	
				ACCIAIERIA FONDERIA CIVIDALE	ITALY	A	
				DALIAN HUARUI HEAVY INDUSTRY	CHINA	A	VENDOR QP REQUIRED ONLY FOR M/s ISGEC
		I		ISGEC HEAVY ENGINEERING LTD	Mujaffarnagar	DR	
				KOCEL MACHINERY CO. LTD	CHINA	DR	
21	IP OUTER CASING M/C	I	QVM-Q-	- HEEP	Hardwar	A	
				- Rossl And Duso	Italy	A	
				-MCE (New name BILFINGER MASCHINENBAU GMBH)	Austria	A	
				-Bruno Presezzi	Italy	A	
				-Nugo Romano	Italy	A	
22	IP INNER CASING CASTING (9% Cr)	I	QVM-Q-	ACCIAIERIA FONDERIA CIVIDALE	ITALY	DR	NO SEPARATE VENDOR QP EXCEPT FOR CFFP
				THE JAPAN STEEL WORKS LTD.	JAPAN	A	
				JAPAN CASTING AND FORGING	JAPAN	A	
				SIEMENS AG	GERMANY	DR	
				VOESTALPINE GIESSEREI LINZ	AUSTRIA	A	
				ISGEC HEAVY ENGINEERING LTD	MUJAFFARNAGAR	DR	
				CFFP,BHEL	Hardwar	A	
23	IP INNER CASING M/C	I	QVM-Q-	HEEP	Hardwar	A	
				Rossl And Duso	Italy	A	
				MCE (New name: BILFINGER MASCHINENBAU GMBH)	Austria	A	
				Bruno Presezzi	Italy	A	
				Nugo Romano	Italy	A	
24	IP ROTOR FORGING 9-10% Cr	II	QVM-Q-	SDF .TERNI	Germany	A	NO SEPARATE VENDOR QP (ALREADY COVERED IN NTPC APPROVED BHEL MQP)
				JAPAN CASTING AND FORGING,JAPAN	Italy	A	
				SAARSCHMIEDE GMBH, GERMANY	Japan	A	
				THE JAPAN STEEL WORKS LTD.,	JAPAN	A	
25	IP TURBINE SHAFT M/C	I	QVM-Q-	- HEEP	Hardwar	A	
				- Rossl And Duso	Italy	A	
				-Bruno Presezzi	Italy	A	
				-Nugo Romano	Italy	A	
				-Siemens AG	Germany	A	
26	IP TURBINE ROTOR		QVM-Q-	Siemens AG Energy Sector	GERMANY	A	
				HEEP	Haridwar	A	

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27	IP STATIONARY & MOVING BLADES BAR STOCK	II	QVM-Q-	Böhler	Austria	A	NO SEPARATE VENDOR QP A*:ONLY FOR HW10687 & HW10786
				Walzwerke	Germany	A	
				Metal Ravne	Slovenia	A	
				Starwire	Ballabhgarh	A	
				Kalyani Carpenter	Pune	A*	
				BGH	GERMANY	A	
28	IP STATIONARY & MOVING BLADES (M/C)	II	QVM-Q-	Leistritz-Nürnberg	Germany	A	
				EnergietechnikEinsal	Germany	A	
				Wuxi Turbine Blade	China	A	
				Officine Meccaniche Zema	Italy	A	
				Wiromet	Poland	A	
				CMSNC Di Menegazzi	Italy	DR	
				Praewest Praezisionswerkstaett	Germany	DR	
				HEEP	Hardwar	A	
				Siemens Ltd	India	DR	
				Euroflex Transmissions (India) Pvt. Ltd.	Hyderabad	DR	
29	IV CV VALVE CASING (MAT) 9-10 %Cr	I	QVM-Q-	VOESTALPINE GIESSEREI LINZ	AUSTRIA	A	QP APPROVAL REQD. FOR STARWIRE, CFFP , ISGEC
				ACCIAIERIA FONDERIA CIVIDALE	ITALY	A	
				LUCCHINI RS S.P.A.	ITALY	DR	
				THE JAPAN STEEL WORKS LTD.	JAPAN	A	
				JAPAN CASTING AND FORGING	JAPAN	A	
				HANWA CO. LTD. (MANUFACTURER: UBE STEELS, JAPAN)	JAPAN	DR	
				SCHMOLZ + BICKENBACH GUSS GMBH	GERMANY	DR	
				STAHLGUSS SAAR GMBH	GERMANY	DR	
				ISGEC HEAVY ENGINEERING LTD	MUJAFFARNAGAR	A	
				LITOSTROJ STEEL LTD.	Slovenia	DR	
				STAR WIRE (INDIA) LTD.	Ballabhgarh	A	
				CFFP, BHEL	Haridwar	A	
30	IV CV CASING M/C	I	QVM-Q-	- HEEP	Haridwar	A	
				- Energy Machines	Ahemdabad	A	
				- Siemens AG Energy Sector	Germany	A	
31	IV CV VALVE ASSEMBLY	I	QVM-Q-	- HEEP	Hardwar	A	
32	IP JOINT BOLTS	I	QVM-Q-	- HEEP + NTPC approved sub-vendors #	Hardwar	A	# REFER NOTE 3
33	IP TURBINE ASSLY	I	QVM-Q-	- Siemens AG Energy Sector	Germany	A	
				HEEP	HARIDWAR	A	
34	IP SHAFT SEALING RING			- HEEP + NTPC approved sub-vendors #	Hardwar	A	# REFER NOTE 3
35	LP TURBINE SHAFT FORGING	II	QVM-Q-	UMP TRADING S.A. (SUPPLY THRU ENERGOMASH, UKRAINE)	SWITZERLAND	DR	NO SEPARATE VENDOR QP (ALREADY COVERED IN NTPC APPROVED BHEL MQP)
				SDF TERNI	Italy	A	
				THE JAPAN STEEL WORKS LTD., JAPAN	Japan	A	
				JAPAN CASTING AND FORGING, JAPAN	Japan	A	
				SAARSCHMIEDE GMBH, GERMANY	GERMANY	A	
				CHINA FIRST HEAVY INDUSTRIES, CHINA	CHINA	DR	
				SC DOOSAN IMGB SA, ROMANIA	ROMANIA	DR	

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				CHINA NATIONAL ERZHONG GROUP, CHINA	CHINA	DR	
				SHANGHAI HEAVY MACHINERY PLANT, CHINA	CHINA	DR	
36	LP TURBINE SHAFT M/C	I	QVM-Q-	- HEEP	Hardwar	A	
				- Rossl And Duso	Italy	A	
				- Nugo Romano	Italy	A	
				- Siemens AG	Germany	A	
37	LP TURBINE ROTOR	I	QVM-Q-	HEEP	Haridwar	A	
38	LP INNER CASING FABRICATION	I	QVM-Q-	- HEEP + NTPC approved sub-vendors#	Haridwar	A	# REFER NOTE 3
39	LP INNER CASING M/C	I	QVM-Q-	- HEEP + NTPC approved sub-vendors#	Haridwar	A	# REFER NOTE 3
40	LP INNER CASING ASSLY	I	QVM-Q-	- HEEP	Haridwar	A	
41	CASING UPPER PART, CASING SIDE WALL (L&R), FRONT WALL (TS&GS)	I	QVM-Q-	- HEEP + NTPC approved sub-vendors#	Haridwar	A	# REFER NOTE 3
42	GUIDE BLADE CARRIER (1L & 1R)	I	QVM-Q-	- HEEP + NTPC approved sub-vendors#	Hardwar	A	# REFER NOTE 3
43	LPT COMPENSATORS	I	QVM-Q-	BOA Bellows and expansion joints	Germany	A	
				Flexatherm expanllow Pvt.Ltd.	VADODRA	A	
				SHANGHAI YONGXIN CORRUGATE PIPE CO LTD	CHINA	A	
				Lonestar Industries	Chennai	A	
				NANTONG SHUGUANG EXPANSION JOINT	CHINA	DR	
				Belman A/S	Denmark	DR	
				Siemens Limited	India	DR	
44	COMPENSATOR PIPING (LP CROSS OVER PIPE, LP EXTRACTION PIPING A1, A2, A3, LP SHAFT SEAL COMPENSATOR, LPT COMPENSATOR FOR CASING	I	QVM-Q-	HATEC HAAG- TECHNISCHER HANDEL	Germany	A	
				LONESTAR INDUSTRIES	India	A	
				SHANGHAI YONGXIN CORRUGATE PIPE CO LTD	CHINA	A	
				UNITECH MACHINES LTD	India	DR	
45	LP STATIONARY/ MOVING BLADE BARS	II	QVM-Q-	- Böhler	Austria	A	NO SEPARATE VENDOR QP A*:ONLY FOR HW10687 & HW10786
				- Walzwerke	Germany	A	
				- Metal Ravne	Slovenia	A	
				-Starwire	Ballabhgarh	A	
				- Kalyani Carpenter	Pune	A*	
				BGH	GERMANY	A	
46	LP ROTOR & CASINGS BLADES FROM BAR (M/C)	I	QVM-Q-	- Leistritz-Nürnberg	Germany	A	
				- Energietechnik Einsal	Germany	A	
				- Wuxi Turbine Blade	China	A	
				Officine Meccaniche Zema	Italy	A	
				Wiromet	Poland	A	
				CMSNC Di Menegazzi	Italy	DR	
				HEEP	Hardwar	A	
47	LP CAST BLADES (CASTED)	I	QVM-Q-	- Consolidated Precision Product	Belgium	A	

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				- PTC	Mehsana	A	
				- IPCL	Bhavnagar	A	
				- PCI Ltd	India	DR	
48	LP BLADES (HOLLOW)	I	QVM-Q-	- Binder	Switzerland	A	
				- Cave	Italy	DR	
				- Wuxi Turbine Blade	China	A	
				- Prime Hitech Engineering Ltd	India	A	
				- VRK Industries	India	DR	
49	LP FORGED BLADES (DROP)	II	QVM-Q-	- Wuxi	China	A	NO SEPARATE VENDOR QP (ALREADY COVERED IN NTPC APPROVED BHEL MQP)
				- C Blade	Italy	A	
				- Piertro Rosa	Italy	A	
				- Siemens Ltd	Gurgaon	DR	
				- Bohler	Austria	A	
50	LP FORGED BLADES (DROP) M/c	II	QVM-Q-	- Pietro Rosa	Italy	A	
				- Wuxi Turbine Blade	China	A	
				- C Blade	Italy	A	
				- Bohler	Austria	A	
				-Siemens Ltd	Gurgaon	DR	
51	LP ASSEMBLY	I	QVM-Q-	- BHEL	Hardwar	A	
52	COUPLING BOLTS & NUTS (HP/IP/LP)	I	QVM-Q-	- HEEP + NTPC approved sub-vendors #	Hardwar	A	# REFER NOTE 3
53	BRG. SHELL FOR JOURNAL BRG (Forging)	II	QVM-Q-	MACKEIL ISPAT AND FORGINGS LTD	KOLKATA	DR	NO SEPARATE VENDOR QP EXCEPT FOR CFFP
				STAR WIRE (INDIA) LTD.	Ballabhgarh	A	
				KISAAN STEELS (PVT.) LTD.	GHAZIABAD	A	
				CHW FORGE (P) LTD	GHAZIABAD	A	
				GOOD LUCK ENGINEERING CO.	GHAZIABAD	A	
				GHAZIABAD FORGINGS PVT LTD	GHAZIABAD	DR	
				R. D. FORGE	GHAZIABAD	DR	
				CFFP, BHEL	HARIDWAR	DR	
				VISHNU FORGE INDUSTRIES LTD.	Bangalore	A	
				RING FORGINGS PVT LTD	Bangalore	DR	
				GHAZIABAD ISPAT UDYOG LTD.	GHAZIABAD	DR	
				VIKRANT FORGE LIMITED	KOLKATA	DR	
				BAY-FORGE LIMITED	TAMIL NADU	A	
54	JOURNAL BEARING	II	QVM-Q-	DAEDONG METAL INDUSTRY CO. LTD	South Korea	DR	
				EURO BEARINGS SRL	Italy	A	
				GFM S.R.L. (SOCIO UNICO)	Italy	DR	
				JOHN CRANE BEARING TECHNOLOGY	Germany	A	
				OMEGA INDUSTRIES (P) LTD	Bhopal	A	
				SHENKE SLIDE BEARING CORPORATI	China	DR	
				SIEMENS LIMITED	India	DR	(Main supplier ; Siemens Germany)
				HEEP	HARIDWAR	A	
				TURBOLINK CO.LTD	Korea	DR	

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55	BEARING PEDESTAL WITH COVER (M/C)	I		- HEEP + NTPC approved sub-vendors	Hardwar	A	
56	EHA FOR TURBINE VALVES	II	QVM-Q-	- Bosch Rexroth AG	Germany	A	
				- Horst Thiele Maschinenbau	Germany	DR	
57	HPSU FOR EHA	II	QVM-Q-	- Bosch Rexroth	Germany*	A	*Supply from Bosch Rexorth Sanand Gujrat
				- Hydac	Germany	A	
				-Reineke Mess-und Regeltechnik	Germany	DR	
				-Keicher Engg	Germany	DR	
				- Hydac	India	DR	
58	NON RETURN VALVE-CRH	I	QVM-Q-	- Sempell	Germany	A	
				- BHEL	Tiruchi	A	
59	AIR COOLED CONDENSOR (Sub-QR Item)	I	QVM-Q-	SPX, Dry Cooling	BELGIUM	A	
				Shuanliang Eco-Energy System Co. Ltd. Jiangsu	CHINA	A	
				Harbin Air Conditioning Co. Ltd	CHINA	A	
				Enexio Germany GmBH	GERMANY	A	
				Beijing Shouhang Resources Saving Co. Ltd	CHINA	A	
				SPIG SPA	ITALY	DR	
				Enexio Cooling Tower Technologies(India) Pvt Ltd	INDIA	DR	
				Paharpur Cooling Tower	INDIA	DR	
				Innospin AG	Switzerland	DR	
				Beijing Longyuan Cooling Technologies	CHINA	DR	
				Hamon Shriram Cottrell	INDIA	DR	
				Hamon Cooling System (Tianjin) Co., Ltd.	CHINA	DR	
				Luoyang LONGHUA Heat Transfer & Energy saving conser	CHINA	DR	
				HHI, China	CHINA	DR	
60	CONDENSOR AIR EVACUATION PACKAGE	I	QVM-Q-	Gardner Denver Nash Machinery	CHINA	A	
				Edwards Ltd	UK	A	
				Guangdong Foshan Pump Factory, Guangdong	CHINA	A	
61	LP HEATER TUBES	I	QVM-Q-	- Apex Tubes Pvt Ltd	India	A	
				- Ratnamani	Ahmedabad& Kutch	A	
				- NEOTISS LTD (OLD NAME: Vallourec Heat Exchanger Tubes Limited)	Hyderabad	A	
				- Remi	Mumbai	A	

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				- Ratandeep	Ahmedabad	A	
				MAXIM TUBES CO. LTD	GUJRAT	DR	
				- Heavy Metals	Ahmedabad	DR	
62	GSC TUBES	I	QVM-Q-	- Ratnamani	Ahmedabad & Kutch	A	
				NEOTISS LTD (OLD NAME: Vallourec Heat Exchanger Tubes Umited)	Hyderabad	A	
				- Remi	Mumbai	A	
				- Ratandeep	Ahmedabad	A	
				- Heavy Metals& Tubes	Ahmedabad	DR	
				- Apex Tubes Pvt Ltd	BEHROR	A	
				- Quality Stainless	HISAR	DR	
				- Bhandari Foils & Tubes	DEWAS, MP	DR	
				- Prakash Steelage	Mumbai	DR	
65	GLAND STEAM CONDENSER	I	QVM-Q-	- HEEP + NTPC approved sub-vendors#	Hardwar	A	# Refer Note 3
66	LP HEATER	I	QVM-Q-	- HEEP + NTPC approved sub-vendors#	Hardwar	A	# Refer Note 3
67	TURBINE INTEGERAL PIPING	I	QVM-Q-	BHEL Piping Centre	Chennai	A	A* means as per approval conditions
				Unitech	Saharanpur	A	
				Bend Joints	Bhopal	A	
				Pal Engg.	Yamunanagar	A	
				Dee Development	Faridabad	A	
				Flash Forge Pvt Ltd	Vishakhapatnam	DR	
				BABY ENGINEERING PVT LTD	TRICHY	DR	
				S & G ENGINEERS PVT LTD	Faridabad	DR	
				GUJRAT INFRA PIPES	BARODA	A*	
				Steel Craft Industries	Yamunanagar	DR	
68	OIL MODULE	II	QVM-Q-	Kelag	Switzerland	A	
				VDL Delmas	Germany	A	
				BARIC	UK	A	
				Hydac India Pvt Ltd	Navi Mumbai	DR	
				AEL	Germany	A	
				Flenco	Italy	A	
				Hydac	Germany	A	
				King Dynamics	Switzerland	A	
69	OIL PURIFICATION SYSTEM	I	QVM-Q-	GEA Westfalia Seperator	Bangalore	A	Centrifuge from Germany
				Alfa Laval (India)	Pune	A	
70	HANGERS & SUPPORT (Fabricated Type)	I	QVM-Q-	Pal Engg.	Yamunanagar	A	
				Darshan	Yamunanagar	A	
				Shape Engg.	Haridwar	A	
				Bend Joints	Bhopal	A	

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				Shape Engg.	Haridwar	A	
				Bend Joints	Bhopal	A	
				Spring Supports Mfg co.	HOWRAH	DR	
				Pipe Supports Co.	Hyderabad	DR	
				Hesterberg Gmbh & Co. Kg	Germany	DR	
				Fast Tech Engineers Pvt. Ltd.	India	DR	
				Bergen Pipe Supports India Pvt Ltd	Chittor, AP	A	
				AAA SUPPORTS PVT LTD	VADODRA	DR	
				Unison Etech	Korea	DR	
71	LP BYPASS SYSTEM	II	QVM-Q-	- CONTROL COMPONENT INDIA PRIVATE LTD.	SRICITY , AP INDIA	A	SUB QR ITEM
				- Bomafa	Germany	A	
				- Welland &Tuxhorn	Germany	A	
				- Parcol S.P.A	Italy	DR	
72	THERMAL INSULATION MATERIAL FOR TURBINE	III	QVM-Q-	Heinrich Tapp Gmbh	Germany	A	
		III		Eugen Arnold Gmbh	Germany	A	
		I		Lloyds Insulations (India) Ltd	India	DR	
73	THERMAL INSULATION MATERIAL FOR TIP	I	QVM-Q-	Lloyds Insulation	India	A	
		I		SHREE ENGINEERS	INDORE	DR	
		I		Indo Bell Insulation (Applicator)	India	DR	
74	VARIABLE LOAD SPRING CAGES	I	QVM-Q-	- Spring Support	Kolkata	A	
		III		- Usega	Germany	A	
		II		- Dee Development	India	DR	
		II		- Pipe Supports Co	Hyderabad	DR	
		I		- Bergen Pipe Supports India Pvt Ltd	Chittor, AP	A	
		II		AAA SUPPORTS PVT LTD	VADODRA	DR	
		II		-Unison Etech	Korea	DR	
75	GLAND STEAM EXHAUSTER WITH MOTOR	I	QVM-Q-	Air MOVEMNET AND CONTROL SYSTEMS	India	DR	
				SK System PVT LTD	India	A	
				DUSTECH ENGINEERS PVT LTD		DR	
				CB Doctor	India	A	
79	HP U-SEAL (NIMONIC) RING FORGING	III	QVM-Q-	SMT EXPORT (M/S FRISA FORJADOS, MEXICO)	INDIA	DR	
				MIDHANI	INDIA	A	
				WARTON IMPORT (M/S SHANGHAI TENGHUI, CHINA)	China	DR	
				FORGITAL	Italy	A	
80	STELLITED/COATED FINISH MACHINED VALVE SEAT / VALVE CONE / VALVE SPINDLE / DIFFUSER	I	QVM-Q-	Sai Surface coating	India	A	QP APPROVAL REQD. FOR INDIAN VENDORS ONLY
		III		Kennametal Stellite GMBH	Germany	A	
		III		Stellba AG	Germany	A	
		I		ATS Techno Pvt. Ltd.	Ahmedabad	A	
		I		Associated Plasmatron Pvt.Ltd.,	THANE	A	
		I		ASM ThermalSpray.	Medak, Telangana	DR	

NOTE 1: IN ADDITION TO ABOVE SOURCES BHEL MAY PROCURE ITEMS FROM SIEMENS, SIEMENS APPROVED SOURCES . BHEL TO SUBMIT DOCUMENTS IN SUPPORT OF SIEMENS APPROVED SOURCE.

NOTE 2: QP/INSPECTION CAT-I QP APPROVAL AND INSPECTION BY NTPC: QP/INSPECTION CAT-II QP APPROVAL BY NTPC,NO PHYSICAL INSPECTION BY NTPC.ACCEPTANCE BASED ON REVIEW OF CONTRACTOR INSPECTION REPORT/ TC. : QP/INSPECTION CAT-III NO QP APL AND INSPECTION BY NTPC. ACCEPTANCE

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BASED ON REVIEW OF COC BY BHEL.

NOTE 3: MQP APPROVED FOR BHEL HARIDWAR SHALL BE USED ON SUB-VENDOR'S WORKS. FABRICATION AND MACHINING VENDORS FOR BHEL TURBINE COMPONENTS AS PER ANNEXURE XXX

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Ref. No.	**Section**	**Title**	**Rev. No.**	**Date**
IN1141; Var.A.2.3.4; PG SU PRO EUS, CW.	15.1.0	Sub-Supplier-Steam-Turbine	00	Oct.2016
The information given in this section is not subject to verification and non fulfillment of it or incorrectness/incompleteness of such information is not subject to any kind of rights or remedies of the Customer whatsoever.				

15.1 Sub Suppliers Steam Turbine

Items and their potential Sub Supplier's

Sl No.	Item	Inspection Category	Siemens QP No.		Sub Supplier Name		Place	Remarks
1	HP OUTER CASING CASTING EXHAUST	II	111130		Voestalpine Giesserei Lucchini Sande Stahlguss GmbH Gröditz Stahlguss Schmolz und Bickenbach	www.voestalpine.com/foundry_linz	Austria Italy Germany Germany Germany	A A* A A A*
2	HP OUTER CASING CASTING INLET	II	111122		Voestalpine Giesserei Sande Stahlguss GmbH	www.voestalpine.com/foundry_linz	Austria Germany	A DR
3	HP OUTER CASING EXHAUST M/C	I	111360		Siemens AG EnergySector MCE Voest Horst Jung Leipert Ludwig Lehner Hans Richter GmbH		Germany Austria Germany Germany Germany Germany	A A A* A A* A*
4	HP OUTER CASING INLET M/C	I	111355		Siemens AG EnergySector MCE Voest Horst Jung Leipert		Germany Austria Germany Germany	A A A* A
5	HP INNER CASING CASTING	II	115112		Voestalpine Giesserei Sande Stahlguss GmbH Lucchini Schmolz &Bickenbach	www.voestalpine.com/foundry_linz	Austria Germany Italy Germany	A A DR DR

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[Siemens AG]

Technical Offer				
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Sl No.	Item	Inspection Category	Siemens QP No.		Sub Supplier Name		Place	Remarks
6	HP INNER CASING M/C LP stationary casings only	I	115310		Siemens AG Energy Sector Siemens AG Energy Sector MCE Voest Horst Jung Leipert Hans Richter GmbH		GermanyUS A Austria Germany Germany Germany	A DR A A* A A*
7	HP TURBINE SHAFT FORGING	II	121101		Saarschmiede S.d.F.Terni JSW (Japan steel works JCFC (Japan Casting&Forging Corp.) Schmiedewerke Gröditz	www.saarschmiede.com www.fucineterni.it www.jsw.co.jp www.jcfc.jp www.stahl-groeditz.de	Germany Italy Japan Japan Germany	A A A A A*
8	HP TURBINE SHAFT M/C	II I	121390		Siemens AG Energy Sector Siemens AG Energy Sector		Germany USA	A DR
9	HP TURBINE ROTOR	I	121390		Siemens AG Energy Sector Siemens AG Energy Sector		Germany USA	A DR
10	HP/ IP STATIONARY & MOVING BLADES BAR STOCK	II	131100		Böhler Einsal Metalravne		Austria Germany Slovenia	A A A*

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Sl No.	Item	Inspection Category	Siemens QP No.		Sub Supplier Name		Place	Remarks
11	HP/ IP STATIONARY & MOVING BLADES (M/C)	II I	131300		SET Leistritz-Nürnberg Energietechnik Einsal	 www.turblade.com	Hungary Germany Germany	A A A
12	ESV & CV CASING (HP VALVES) MAT IVCV (IP VALVES) Casing	II	141111		Sande Stahlguss Voestalpine Giesserei	 www.voestalpine.com/foundry_linz	Germany Austria	A A
	ESV & CV CASING (HP VALVES) M/C IVCV Casing (IP VALVES) M/c	I	141340		Siemens Energy Sector		Germany	A
13	HP VALVE ASSEMBLY IVCV Valve Assembly	I	145401		Siemens AG Energy Sector		Germany	A
14	HP JOINT BOLTS	I	165220		Stahlberg GmbH	www.stahlberg-gmbh.de	Germany	A
15	HP TURBINE ASSLY	I	199420		Siemens AG Energy Sector		Germany	A
15A	HP U SEAL	II	148353		Siemens AG Energy Sector Rosswag Kind & Co Deloro Metal Ravne	 www.edelstahl-rosswag.de www.kind-o.de/kc_2010/index.html www.stellite.de	Germany Germany Germany Germany Slovenia	N (for all)

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IN1141; Var.A.2.3.4; PG SU PRO EUS, CW.	15.1.0	Sub-Supplier-Steam-Turbine	00	Oct.2016
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Sl No.	Item	Inspection Category	Siemens QP No.		Sub Supplier Name		Place	Remarks
15B	BREACH NUT	III	188300		Siemens AG Energy Sector Rosswag Kind & Co KST Stellba Deloro Metal Ravne	 www.edelstahl-rosswag.de www.kind-co.de/kc_2010/index.html www.kst-berlin.de www.stellba.ch/cms/index.php?lang=de www.stellite.de	Germany Germany Germany Germany Switzerland Germany Slovenia	N (for all)
15C	HP SUPPORT & THRUST RING	III	188300		Siemens AG Energy Sector Rosswag Kind & Co KST Stellba Deloro Metal Ravne	 www.edelstahl-rosswag.de www.kind-co.de/kc_2010/index.html www.kst-berlin.de www.stellba.ch/cms/index.php?lang=de www.stellite.de	Germany Germany Germany Germany Switzerland Germany Slovenia	N (for all)
15D	HP INLET INSERT CASTING & HP EXHAUST FLANGE	II	188300		Siemens AG Energy Sector Rosswag Kind & Co KST Stellba Deloro Metal Ravne	 www.edelstahl-rosswag.de www.kind-co.de/ www.kst-berlin.de www.stellba.ch/ www.stellite.de	Germany Germany Germany Germany Switzerland German Slovenia	N (for all)
15E	SEALING RING	III	162302		Siemens AG Energy Sector Rosswag Kind & Co KST Stellba Deloro Metal Ravne	 www.edelstahl-rosswag.de www.kind-co.de/kc_2010/index.html www.kst-berlin.de www.stellba.ch/cms/index.php?lang=de www.stellite.com	Germany Germany Germany Germany Switzerland Germany Slovenia	N (for all)

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Sl No.	Item	Inspection Category	Siemens QP No.		Sub Supplier Name		Place	Remarks
15F	HP SHAFT SEALING RING	III	162304		Siemens AG Energy Sector Rosswag Kind & Co KST Stellba Metal Ravne	 www.edelstahl-rosswag.de www.kind-co.de/kc_2010/index.html www.kst-berlin.de www.stellba.ch/cms/index.php?lang=de	Germany Germany Germany Germany Switzerland Slovenia	N (for all)
16	IP OUTER CASING CASTING	II	111110		Buderus Guss Siempelkamp Heidenheimer Giesserei Friedrich Wilhelm Hütte Cividale Ergocast	www.guss.buderus.de www.siempelkamp.com	Germany Germany Germany Germany Italy Germany	A A A A A A
17	IP OUTER CASING M/C	II	111345		MCE-MAP Siemens AG Energy Sector G.M.W. Präzisions GmbH Leipert	www.mce-map.com	Austria Germany Germany Germany	A (for all)
18	IP INNER CASING CASTING	II	112100		Voestalpine Giesserei Sande Stahlguss		Austria Germany	A DR
19	IP INNER CASING M/C	II	112330		MCE-MAP Siemens AG EnergySector Horst Jung Leipert Ludwig Lehner Hans Richter GmbH	www.mce-map.com	Austria Germany Germany Germany Germany Germany	A A A* A A* A*

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Technical Offer				
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The information given in this section is not subject to verification and non fulfillment of it or incorrectness/incompleteness of such information is not subject to any kind of rights or remedies of the Customer whatsoever.

Sl No.	Item	Inspection Category	Siemens QP No.		Sub Supplier Name		Place	Remarks
20	IP ROTOR FORGING	II	121101		Saarschmiede	www.saarschmiede.com	Germany	A
					S.d.F.Terni	www.fucineterni.it	Italy	A
					Doosan	www.doosanheavy.com	Korea	DR
					JSW (Japan steel works)	www.jsw.co.jp	Japan	A
					JCFC (Japan Casting&Forging Corp.)	www.jcfc.jp	Japan	A
					Schmiedewerke Gröditz	www.stahl-groeditz.de	Germany	DR
					Doosan IMGB	www.doosanimgb.com	Romania	DR
					Buderus Edelstahl	www.buderus-steel.com	Germany	DR
					Pilsen Steel	www.pilsensteel.cz	Czech Rep.	DR
21	IP TURBINE SHAFT M/C	I	121390		Siemens AG Energy Sector		Germany	A
					Franco Tosi		Italy	A
					PG-P1 Charlotte		USA	DR
22	IP TURBINE ROTOR	I	121390		Siemens AG Energy Sector		Germany	A
					PG-P1 Charlotte		USA	DR
27	IP JOINT BOLTS	I			Stahlberg		Germany	A
					Zapp Mechanical		Poland	A
28	IP TURBINE ASSLY	II I	199410		Siemens AG Energy Sector		Germany	A
28A	IP THREADED RING	III	148341 oder 148351 gepanzert		Siemens AG Energy Sector		Germany	
					Rosswag	www.edelstahl-rosswag.de	Germany	N (for all)
					Kind & Co	www.kind-co.de/kc_2010/index.html	Germany	
					Stellba	www.stellba.ch/cms/index.php?lang=de	Switzerland	
					Deloro	www.stellite.de	Germany	
					Metal Rayne		Slovenia	

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Technical Offer				
Ref. No.	**Section**	**Title**	**Rev. No.**	**Date**
IN1141; Var.A.2.3.4; PG SU PRO EUS, CW.	15.1.0	Sub-Supplier-Steam-Turbine	00	Oct.2016
The information given in this section is not subject to verification and non fulfillment of it or incorrectness/incompleteness of such information is not subject to any kind of rights or remedies of the Customer whatsoever.				

Sl No.	Item	Inspection Category	Siemens QP No.		Sub Supplier Name		Place	Remarks
28B	IP ANGLE SEALING RING	III	148344		Siemens AG Energy Sector Rosswag Kind & Co Stellba Delorox Metal Ravne	www.edelstahl-rosswag.de www.kind-co.de/kc_2010/index.html www.stellba.ch/cms/index.php?lang=de www.stellite.de	Germany Germany Germany Switzerland Germany Slovenia	N (for all)
28C	IP INLET CONNECTIONS IP INLET INSERT	II	188300		Siemens AG Energy Sector Rosswag Kind & Co Stellba Deloro Metal Ravne	www.edelstahl-rosswag.de www.kind-co.de/kc_2010/index.html www.stellba.ch/cms/index.php?lang=de www.stellite.de	Germany Germany Germany Switzerland Germany Slovenia	N (for all)
28D	IP SHAFT SEALING	III	162304		Siemens AG Energy Sector Rosswag Kind & Co Stellba Deloro Ubruek Metal Ravne Cross	www.edelstahl-rosswag.de www.kind-co.de/kc_2010/index.html www.stellba.ch/cms/index.php?lang=de www.stellite.de www.ubroek.nl	Germany Germany Germany Switzerland Germany Netherlands Slovenia	N (for all)
29	LP TURBINE SHAFT FORGING	II	121151		Saarschmiede S.d.F.Terni Doosan JSW (Japan steel works JCFC (Japan Casting&Forging Corp.) Schmiedewerke Groditz Doosan IMG	www.saarschmiede.com www.fucineterni.it www.doosanheavy.com www.jsw.co.jp www.jcfc.jp www.stahl-groeditz.de	Germany Italy Korea Japan Japan Germania Romania	A A DR A A DR DR

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Technical Offer				
Ref. No.	Section	Title	Rev. No.	Date
IN1141; Var.A.2.3.4; PG SU PRO EUS, CW.	15.1.0	Sub-Supplier-Steam-Turbine	00	Oct.2016
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Sl No.	Item	Inspection Category	Siemens QP No.		Sub Supplier Name		Place	Remarks
30	LP TURBINE SHAFT M/C	II I	121370		Siemens AG Energy Sector Siemens AG Energy Sector		Germany USA	A DR
31	LP TURBINE ROTOR	I	121370		Siemens AG Energy Sector Siemens AG Energy Sector		Germany USA	A DR
32	LP INNER CASING-I Casted Design	I	115130		Buderus Guss Siempelkamp Heidenheimer Giesserei Torgelow Eisengiesserei		Germany Germany Germany Germany	A A A A
	LP INNER CASING-I Fabricated Design	I	115130		PT Siemens Indonesia T+S Prämab Popeci Dalian Heavy Bor-Pol Zhoule	 www.technologie-plus-service.de www.praemab-burg.de http://shzhoule.com/en	Indonesia Germany Germany Romania China Poland China	A A A A* DR A DR
	LP INNER CASING-(M/C)	I	113365		Siemens AG Horst Jung GmbH MCE-MAP Siemens AG Energy Sector Rothenpieler Leipert	 www.horst-jung.com www.mce-map.com	Germany Germany Austria Germany Germany Germany	A A* A A A A
34	LP INNER CASING-1&2 ASSLY	I	199405		Siemens AG Energy Sector		Germany	A
35	LP OUTER CASING (FRONT WALL, GIRDER, UPPER PART)	I	111220		Prämab T&S (Technologie+Service) PT Siemens Indonesia BOR-POL Ltd.	www.praemab-burg.de www.technologie-plus-service.de	Germany Germany Indonesia Poland	A A A A

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Technical Offer				
Ref. No.	**Section**	**Title**	**Rev. No.**	**Date**
IN1141; Var.A.2.3.4; PG SU PRO EUS, CW.	15.1.0	Sub-Supplier-Steam-Turbine	00	Oct.2016
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Sl No.	Item	Inspection Category	Siemens QP No.		Sub Supplier Name		Place	Remarks
36	GUIDE BLADE CARRIER (GUIDE BLADE RINGS)	I	161201		SET PTSI Coupe Foundries Ergocast Akdas Ningbo Riyue Foundry		Hungary Indonesia Great Britain Germany Turkey China	A A A A DR DR
37	LPT COMPENSATORS FOR CAP	II I	TLV 1501		Eickhoff Ha-Tec	www.iag-gmbh.de www.hatecgmbh.de	Germany Germany	A A*
38	LP CROSS OVER PIPE	I	TLV 0805		T&S (Technologie+Service) Eickhoff EHR (Essener Hochdruck Rohrleitungsbau) Ha-Tec	www.technologie-plus-service.de www.iag-gmbh.de www.essener-hochdruck.de	Germany Germany Germany Germany	A A A A
39	LP STATIONARY/ MOVING BLADES FROM BAR	II	131120		Böhler Einsal Metalravne WTB		Austria Germany Slovenia China	N N N DR
	LP STATIONARY BLADES FROM BAR (M/C)	I	132300		SET Leistritz-Nürnberg Präwest Energietechnik Einsal ZEMA WTB	 www.turblade.com	Hungary Germany Germany Germany Italy China	A A A A A A
40	LP CAST BLADES (CASTED)	II	131300		Zollern ESCO		Germany Belgium	A A
41	LP BLADES (HOLLOW)	II	131260		Binder		Switzerland	A

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Technical Offer				
Ref. No.	**Section**	**Title**	**Rev. No.**	**Date**
IN1141; Var.A.2.3.4; PG SU PRO EUS, CW.	15.1.0	Sub-Supplier-Steam-Turbine	00	Oct.2016
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Sl No.	Item	Inspection Category	Siemens QP No.		Sub Supplier Name		Place	Remarks
42	LP MOVING BLADES FROM BARS				Metal Raven Böhler Einsal		Slovenia Germany Germany	A A A
43	LP FORGED BLADES (DROP)	II	132150		WTB Böhler Leistritz Remscheid Sumitomo Pietro Rosa C-Blade Leistritz ATC	www.turblade.com www.bohler-edelstahl.com www.leistritz.com	China Austria Germany Japan Italy Italy USA	A A A A A A A
			132373		WTB Böhler Leistritz Remscheid Sumitomo Pietro Rosa C-Blade Leistritz ATC FHI MIC Hong Yuan Forgging	www.turblade.com www.bohler-edelstahl.com www.leistritz.com	China Austria Germany Japan Italy Italy USA Germany Germany China	A A A A A A A A* A* DR

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Patratu Vidyut Utpadan Nigam Limited ★ Distt-Ramgarh(Jharkhand) ★ C & M Deptt.

Technical Offer				
Ref. No.	**Section**	**Title**	**Rev. No.**	**Date**
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Sl No.	Item	Inspection Category	Siemens QP No.		Sub Supplier Name		Place	Remarks
43	LP FORGED BLADES (DROP) M/c	II	132370		Pietro Rosa		Italy	A
					Sumitomo		Japan	A
					WTB		China	A
					Menegazzi		Italy	A
					Leistritz ATC		USA	A
		I			Böhler		Austria	A
					Leistritz Remscheid		Germany	A
					C-Blade		Italy	A
					FHI		Germany	A*
					MIC		Germany	A*
			132371		Pietro Rosa		Italy	A
					Sumitomo		Japan	A
					WTB		China	A
					Menegazzi		Italy	A*
					Leistritz ATC		USA	A
					Böhler		Austria	A
					Leistritz Remscheid		Germany	A
					C-Blade		Italy	A
					FHI		Germany	A*
					MIC		Germany	A*
	LP SHAFT SEALING RING	III	162304		Siemens AG Energy Sector		Germany	N (for all)
					Rosswag	www.edelstahl-rosswag.de	Germany	
					Kind & Co	www.kind-co.de/kc_2010/index.html	Germany	
					Stellba	www.stellba.ch/cms/index.php?lang=de	Switzerland	
					Deloro	www.stellite.de	Germany	
					Ubruek	www.ubroek.nl	Netherlands	
					Cross			

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Technical Offer				
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IN1141; Var.A.2.3.4; PG SU PRO EUS, CW.	15.1.0	Sub-Supplier-Steam-Turbine	00	Oct.2016
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Sl No.	Item	Inspection Category	Siemens QP No.		Sub Supplier Name		Place	Remarks
44	COUPLING BOLTS & NUTS (HP/IP/LP)	I	TLV		Stahlberg (solid bolts) **Pilgrim (from Barh)**		Germany	A A
45	BRG. SHELL FOR JOURNAL BRG (Forging)	II	TLV 2660 TLV		Eurobearings John Crane Bearing Technology Waukesha	www.eurobearings.com	Italy Germany	N (for all)
46	BEARING SHELL & THRUST PAD M/C	II	TLV 2660 TLV		Eurobearings John Crane Bearing Technology Waukesha	www.eurobearings.com	Italy Germany USA, GB	N (for all)
47A	BEARING PEDESTAL WITH COVER (Casting)	II	TLV		BuderusGuss Ergocast Coupe Foundries Akdas Ningbo RiyueFoundry Siemens Eroemuetechnika Schuler Guss	www.guss.buderus.de	Germany Germany Great Britain Turkey China Hungary Germany	N N N N N N N
47B	BEARING PEDESTAL WITH COVER (M/C)				Siemens EroemuetechnikaKFT AGL Eurobearings		Hungary Germany Italia	N N N
48	ELECTRO HYDRAULLIC ACTUATOR (STEAM VALVES)	II	TLV 2100		Bosch Rexroth AG Thiele GmbH	www.boschrexroth.com www.thiele-hydraulik.de	Germany Germany	A A*
	SERVOMOTOR & VALVE FOR CRH-NRV	II	TLV2005/ TLV2007 TLV 100		Sempel AG Weir Valves and Controls USA Inc.	www.sempell.com www.weirvalve.com	Germany US	A A

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Technical Offer				
Ref. No.	**Section**	**Title**	**Rev. No.**	**Date**
IN1141; Var.A.2.3.4; FG SU PRO EUS, CW.	15.1.0	Sub-Supplier-Steam-Turbine	00	Oct.2016
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Sl No.	Item	Inspection Category	Siemens QP No.		Sub Supplier Name		Place	Remarks
69	THERMAL INSULATION	II			Tapp Isolation		Germany	N
70	PRESSED LP DIFFUSOR				Zhoule Bor-Pol		China Poland	DR A

Remarks

A: Approved

A*: vendor experience with m/s Siemens Germany to be furnished for similar or higher rating turbine. In case of casting & forging new suppliers, the creep data to be furnished for review along with vendor experience.

N: The m/s Siemens proposed vendor is accepted by NTPC based on m/s Siemens experience with the vendor for similar and higher rating items

DR: vendor details including experience to be furnished

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Patratu Vidyut Utpadan Nigam Limited ★ Distt-Ramgarh(Jharkhand) ★ C & M Deptt.

SUB VENDOR LIST FOR TG VALVES((TRICHY)						
PROJECT: PATRATU STPS (3 X 800 MW)						
PACKAGE: EPC						
CONTRACT NO: 9585-001-02						
Sno	Item Description	QP CAT	Proposed Sub Supplier	Place	BARH-Approval status / Cat	Remarks
1	HP BY PASS SYSTEM	I	BHEL	Trichy	DR	
	(SUB-QR ITEM)	I	CCI	Sweden / Switzerland	A	
		I	Sempell AG	Germany	A	
		I	Hora	Germany	A	
		I	Welland & Tuxhorn	Germany	DR	
		I	Bopp & Reuther	Germany	A	
2	ACTUATORS	REFER C&I LIST ENCLOSED TO THE LOA/NOA				
3	CONVENTIONAL VALVES GATE GLOBE & NRV - ALL CLASS RATINGS	I	BHEL	Trichy	A	
		I	Meiwa (TOA)	Japan	A	TOA valves are offered thro M/S Meiwa
		I	Velan	Canada	A	
		I	Kokusai (OKANO)	Japan	A	OKANO valves are offered thro M/S Kokusai
		I	Babcock power Espana	Spain	A	
		I	Flow serve (Edward Valve)	USA	DR	Edward Valves are offered thro M/S Flowserve
		I	CRIS	France	DR	
		I	TYCO (Ramondi, Dewrance)	Chennai	A	(Ramondi & Dewrance are now with M/S Tyco)AS PER NTPC APPROVED RATING & SIZE
		I	Xomax Sanmar	Viralimalai	A	AS PER NTPC APPROVED RATING & SIZE
		I	L&T (Audco)	Chennai,Coimbatore	A	AS PER NTPC APPROVED RATING & SIZE
		I	Leader Valves	Jalandar	A	AS PER NTPC APPROVED RATING & SIZE
		I	Fouress	Aurangabad	A	AS PER NTPC APPROVED RATING & SIZE
		I	Niton Valve	Mumbai,Aurangabad	A	AS PER NTPC APPROVED RATING & SIZE
4	CRH-7,8,9 - DEAERATOR PEGGING VALVES	I	BHEL	Trichy	A	
		I	Babcock power Espana	Spain	A	
		I	Petrol Valve	Italy	A	
		I	L&T (Audco)	Chennai	DR	
		I	Leader	Jalandar	DR	
		I	Niton Valve	Mumbai	DR	
5	Extraction QCNRV's & CRHNRV's	I	BHEL	Trichy	DR	
6	Angle Valves / Angle Drain Valves	I	BHEL	Trichy	DR	

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★ Patratu Vidyut Utpadan Nigam Limited ★ Distt-Ramgarh(Jharkhand) ★ C & M Deptt.

A Yadav
Amit Yadav
Mgr. / PS-MKTG.
BHEL

Appendix B, Page 96 of 278

एनटीपीसी NTPC	Project : PATRATU STPP(3X800MW) Package : EPC Contractor : BHEL, Hyderabad Contract No.:	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUBCONTRACTOR APPROVAL SUB SYSTEM: BFP, Drive Turbine, Heaters (HP, LP) Drain Cooler and Deaerator	Ref No.: 9585-001-02 Revision No.: 00 Date: 05.04.2017

SN	ITEM	QP/ INS-PN CAT *	QP No. xxxx-110	QP SUB-MISSION SCHEDULE	QP APPL SCHEDULE	PROPOSED SUB SUPPLIER	PLACE	SS APPL STATUS / CAT	SS DETAIL SUB-SCHEDULE	SC APPL SCHEDULE	REMARKS
1	BFP-PUMP CASING (OUTER) / BFP DISCHARGE COVER/ CASING COVER/ DISCHARGE NOZZLE	I	QVM-Q-301			PYUNG SAN METAL	KOREA	N			
		I				UMETOKU CO., LTD.,	JAPAN	N			
		I				MURABAYASHI	JAPAN	N			
		I				CFFP,	HARDWAR	N			
		I				RING MILL SPA,	ITALY	N			
		I				FOMAS	I TALY	N			
		I				HYUNJIN MATERIALS	JAPAN	N			
		I				HYUNJIN MATERIALS	KOREA	N			
		I				MYSCO	KOREA	N			
2	BFP PUMP CASING (INNER)	I	QVM-Q-301			HIMET	KOREA	N			
		I				WON KANG Material	KOREA	N			
		I				KOMATSU CASTEX	JAPAN	N			
		I				SIMPLEX CASTING Ltd	BHILAI	N			
		I				VOIST ALPINE	AUSTRIA	N			
		I				UP STEEL	MUZAFFAR NAGAR	N			
3	BFP SHAFT	I	QVM-Q-301			UMETOKU CO, LTD	JAPAN	N			
		I				DAIDO STEEL	JAPAN	N			
		I				KUSAKAWA TEKKOU	JAPAN	N			
		I				CFFP	HARDWAR	N			
		I				NISHO IWAI	JAPAN	N			
		I				FOMAS	ITALY	N			
		I				FORGIA RAPIDA	ITALY	N			
		I				MURABAYASHI(MIYAZAKI TEKKOU)	JAPAN	N			
4	BFP BALANCE DRUM SPRING DISC	I	QVM-Q-301			FIRTH VICKERS	UK	N			
		I				TAYLOR FORGING	UK	N			

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एनटीपीसी NTPC	Project : PATRATU STPP(3X800MW) Package : EPC Contractor : BHEL, Hyderabad Contract No.:	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUBCONTRACTOR APPROVAL SUB SYSTEM: **BFP, Drive Turbine, Heaters (HP, LP) Drain Cooler and Deaerator**	Ref No.: 9585-001-02 Revision No.: 00 Date: **05.04.2017**

SN	ITEM	QP/ INS-PN CAT *	QP No. xxxx-110	QP SUB-MISSION SCHEDULE	QP APPL SCHEDULE	PROPOSED SUB SUPPLIER	PLACE	SS APPL STATUS / CAT	SS DETAIL SUB-SCHEDULE	SC APPL SCHEDULE	REMARKS
		I				FIRTH RIXON RINGS LTD(FORMERLY AURORA FORGINGS)	UK	N			
		I				BHEL	HYDERABAD	N			
5	BFP IMPELLERS/DIFFUSERS	I	QVM-Q-301			YPC LTD.,	KOREA	N			
		I				EBARA METAL	JAPAN	N			
		I				Jingsung (formerly komatsu)	JAPAN	N			
6	BFP SUCTION BRANCH/RING SECTION/SUCTION	I	QVM-Q-301			UP STEEL	MUZAFFARNAGAR	N			
		I				WEIR PUMPS LTD	UK	N			
		I				HINDUSTAN UDYOG LTD	KOLKATA	N			
		I				PTC	LUCKNOW	N			
7	BFP SPUN CAST / FORGED TUBES (IMPELLER & CASING WEAR RINGS) ***	I	QVM-Q-301			FIRTH VICKERS	UK	N			
		I				PAHLADRAI STEEL FORGINGS	KANPUR	N			
		I				FIRTH RIXON RINGS LTD(FORMERLY AURORA FORGINGS)	UK	N			
		I				RELY METPRO	S AFRICA	N			
		I				TAYLOR FORGING	UK	N			
8	BOILER FEED PUMP	I	QVM-Q-301			MHI	JAPAN	A			SUB-QR ITEM
		I	QVM-Q-301			BHEL	HYDERABAD	DR			SUB-QR ITEM
9	BP PUMP CASING	I	QVM-Q-302			HIMET	KOREA	N			
		I				EBARA METAL	JAPAN	N			
		I				KOMATSU CASTEX	JAPAN	N			
		I				WON KANG Material	KOREA	N			

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Patratu Vidyut Utpadan Nigam Limited ★ Distt-Ramgarh(Jharkhand) ★ C & M Deptt.

एनटीपीसी NTPC	Project : PATRATU STPP(3X800MW) Package : EPC Contractor : BHEL, Hyderabad Contract No.:	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUBCONTRACTOR APPROVAL SUB SYSTEM: BFP, Drive Turbine, Heaters (HP, LP) Drain Cooler and Deaerator	Ref No.: 9585-001-02 Revision No.: 00 Date: 05.04.2017

SN	ITEM	QP/ INS-PN CAT *	QP No. xxxx-110	QP SUB-MISSION SCHEDULE	QP APPL SCHEDULE	PROPOSED SUB SUPPLIER	PLACE	SS APPL. STATUS / CAT	SS DETAIL SUB-SCHEDULE	SC APPL. SCHEDULE	REMARKS
		I				SIMPLEX CASTING LTD	BHILAI	N			
		I				VOIST ALPINE,	AUSTRIA	N			
		I				UP STEEL	MUZAFFAR NAGAR	N			
		I				SUNG-SHIN M-TECH	KOREA	N			
		I				ISGEC	MUZAFFAR NAGAR	N			
		I				SUNG-SHIN M-TECH	KOREA	N			
		I				SIMPLEX CASTING	BHILAI/RAIPUR	N			
10	BP IMPELLER	I	QVM-Q-302			YPC LTD.,	JAPAN	N			
		I				*EBARA METAL	JAPAN	N			
		I				Jingsung (formely komatsu)	JAPAN	N			
11	BP SHAFT (FORGING)	I	QVM-Q-302			MURABAYASHI (MIYAZAKI TEKKOU)	JAPAN	N			
		I				UMETOKU CO., LTD.	JAPAN	N			
		I				DIADO STEEL	JAPAN	N			
		I				KUSAKAWA TEKKOU	JAPAN	N			
		I				FOMAS	ITALY	N			
		I				VISHNU FORGE	BANGALORE	N			
		I				NISSOIWAI	JAPAN	N			
		I				FORGIA RAPIDA	ITALY	N			
		I				KUSAKAWA IRON WORKS	JAPAN	N			
12	BP WEAR RINGS(FORGED TUBES)	I	QVM-Q-302			FIRTH VICKERS	UK	N			
						PAHLADRAI STEEL FORGINGS	KANPUR	N			
						FIRTH RIXON RINGS LTD(FORMERLY	UK	N			

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Patratu Vidyut Utpadan Nigam Limited C & M Deptt. Dist-Ramgarh (Jharkhand)

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एनटीपीसी NTPC	Project : PATRATU STPP(3X800MW) Package : EPC Contractor : BHEL, Hyderabad Contract No.:	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUBCONTRACTOR APPROVAL SUB SYSTEM: **BFP, Drive Turbine, Heaters (HP, LP) Drain Cooler and Deaerator**	Ref No.: 9585-001-02 Revision No.: 00 Date: **05.04.2017**

SN	ITEM	QP/ INS-PN CAT *	QP No. xxxx-110	QP SUB-MISSION SCHEDULE	QP APPL SCHEDULE	PROPOSED SUB SUPPLIER	PLACE	SS APPL STATUS / CAT	SS DETAIL SUB-SCHEDULE	SC APPL SCHEDULE	REMARKS
						AURORA FORGINGS)					
						RELY METPRO	S AFRICA	N			
13	BOOSTER PUMP(TD)	I	QVM-Q-302			MHI	JAPAN	A			
						BHEL	HYDERABAD	A			MHI DESIGN
14	CEP PUMP CASING	I	QVM-Q-303			FIRTH VICKERS		N			
		I	QVM-Q303			WAKATSUKI KOUSAKUSYO	JAPAN	N			
		I	QVM-Q-303			ABB-ABL-LTD	SHAHBAD	N			
		I				SIMPLEX	BHILAI	N			
		I				UPPAL FERROCAST	HYDERABAD	N			
		I				HYUSONG IND	KOREA	N			
						KIMURA CASTINGS	JAPAN	N			
						EBARA METAL	JAPAN	N			
						FUJIMOTO	JAPAN	N			
						CHUZOU					
15	BELL MOUTH (SUCTION BELL)	I	QVM-Q-303			HYOSUNG INDUSTREIS CO.	KOREA	N			
		I				KIMURA CASTING	JAPAN	N			
		I				EBARA METAL	JAPAN	N			
		I				WAKATSUKI KOUSAKUSYO	JAPAN	N			
		I				ABB-ABL-LTD	SHAHBAD	N			
		I				SIMPLEX	BHILAI	N			
		I				UPPAL FERROCAST	HYDERABAD	N			
16	STAGE (DELIVERY) BOWL	I	QVM-Q-303			HIMET	KOREA	N			
		I				WON KANG Mat.	KOREA	N			
		I				EBARA METAL	JAPAN	N			
		I				ABB-ABL-LTD	SHAHBAD	N			

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एनटीपीसी NTPC	Project : PATRATU STPP(3X800MW) Package : EPC Contractor : BHEL, Hyderabad Contract No.:	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUBCONTRACTOR APPROVAL SUB SYSTEM: **BFP, Drive Turbine, Heaters (HP, LP) Drain Cooler and Deaerator**	Ref No.: 9585-001-02 Revision No.: 00 Date: **05.04.2017**

SN	ITEM	QP/ INS-PN CAT *	QP No. xxxx-110	QP SUB-MISSION SCHEDULE	QP APPL SCHEDULE	PROPOSED SUB SUPPLIER	PLACE	SS APPL STATUS / CAT	SS DETAIL SUB-SCHEDULE	SC APPL SCHEDULE	REMARKS
		I				SIMPLEX	BHILAI	N			
		I				UPPAL FERROCAST	HYDERABAD	N			
						SUNG-SHIN M-TECH	KOREA	N			
						YPC LTD	KORA	N			
17	CEP IMPELLR	I	QVM-Q-303			YPC LTD.,	JAPAN	N			
		I				JINGSUNG (formerly komatsu)	JAPAN	N			
		I				EBARA METAL	JAPAN	N			
		I				KOMASTSU METAL ENGG.	JAPAN	N			
18	CEP SHAFT (FORGING)	I	QVM-Q-303			UMETOKU CO. LTD.,	JAPAN	N			
		I				MURABAYASHI	JAPAN	N			
		I				SANDVIK	SWEDEN	N			
		I				VISHNU FORGE	BANGALORE	A			
		I				CFFP	HARDWAR	N			
		I				FORGIA RAPIDA	ITALY	N			
		I				FOMAS	ITALY	N			
19	CEP WEAR RINGS	I	QVM-Q-303			FIRTH VICKERS	UK	N			
						PAHLADRAI STEEL FORGINGS	KANPUR	N			
						FIRTH RIXON RINGS LTD (FORMERLY AURORA FORGINGS)	UK	N			
						RELY METPRO	S AFRICA	N			
						TAYLOR FORGING	UK	N			
20	CONDENSATE EXTRACTION PUMP	I	QVM-Q-303			MHI	JAPAN	A			SUB-QR ITEM
						BHEL	HYDERABAD	DR			SUB-QR ITEM
21	JOURNAL BEARING(BFP	III				YAMATO METAL	JAPAN	N			

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	AND BP)	III				KONGO COLMET MFG. CO. LTD.	JAPAN	N			
		III				OSAKA ASAHI METAL MFG. CO. LTD.,	JAPAN	N			
		III				GLYCO METAL LTD.	UK	N			
		III				COLHERENE	UK	N			
		III				MITCHEL,	UK	N			
		III				WAUKESHAH (GLACIER)	UK	N			
		I				MITCHEL	BANGALORE	DR			
						DAE DONG METAL IND.	KOREA	DR			
22	JOURNAL BEARING CUM THRUST BEARING FOR CEP	III				HARADA (JAPAN)	JAPAN	N			
		III				KINGSBURY	USA	N			
		III				MITCHEL	UK	N			
		III				WAUKESHAH (GLACIER)	UK	N			
		I				MITCHEL INDIA	BANGLORE	DR			
23	HYDRAULIC COUPLING	I	QVM-Q-304			VOITH	GERMANY	A			
		I				VOITH	HYDERABAD	DR			
24	CONNECTING COUPLING between Motor & HC BFP BP & CEP.	I	QVM-Q-305			SEISA	JAPAN	N			
		I				DIADO PRECISION INDUSTRIES	JAPAN	N			
		I				NIPPON PILLAR	JAPAN	N			
		I				EAGLE INDUSTRY	JAPAN	N			
		I				FLEXIBOX,	UK	N			
		I				EUROFLEX TRANSMISSION,	HYDERABAD	N			

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एनटीपीसी NTPC	Project : PATRATU STPP(3X800MW) Package : EPC Contractor : BHEL, Hyderabad Contract No.:	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUBCONTRACTOR APPROVAL SUB SYSTEM: **BFP, Drive Turbine, Heaters (HP, LP) Drain Cooler and Deaerator**	Ref No.: 9585-001-02 Revision No.: 00 Date: **05.04.2017**

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		I				EUROFLEX LTD.	UK	N			
		I				BIBBY TRANSMISSION (TURBOFLEX)	UK	N			
25	SUCTION STRAINERS FOR CEP, BP & BFP	I	QVM-Q-307			GUJRAT OTTOFIT	AHMEDABAD	A			
		I				MULTITEX	DELHI/NOIDA	A			
26	THRUST BEARING (BFP, BP & CEP)	III				DAIDO METAL	JAPAN	N			
		III				ROLLS ROYCE MARINE JAPAN (MITCHEL BRGS)	UK	N			
		III				WAUKESHAH (GLACIER)	UK	N			
		III				KINGSBURY	USA	N			
		III				MITCHELL BRGS	UK	N			
		I				MITCHEL BRGS	BANGLORE	DR			
						DAE DONG METAL IND.	KOREA	DR			
27	MECHANICAL SEALS (BFP, BP & CEP)	III				NIPPON PILLAR	JAPAN	N			
		III				FLOWSERVE	USA	N			
		III				FLOW SERVE SANMAR	CHENNAI	N			FOR BP & CEP ONLY
		III				EAGLE BURMANN INDIA	MUMBAI	N			-DO-
		III				EAGLE BURUGMAN	JAPAN/GERMANY	N			
28	TURBINE OUTER CASING & STOP VALVE BODY CASING	I	QVM-Q-308			VOIST ALPINE	AUSTRIA	A			
		I				SANDE-STAHL	GERMANY	A			
		I				CFFP,	HARDWAR	A			
		I				UP STEELS	MUJAFARNAGAR	A			
		I				STAR WIRES	BALLABGARH	A			

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एनटीपीसी NTPC	Project : PATRATU STPP(3X800MW) Package : EPC Contractor : BHEL, Hyderabad Contract No.:	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUBCONTRACTOR APPROVAL SUB SYSTEM: **BFP, Drive Turbine, Heaters (HP, LP) Drain Cooler and Deaerator**	Ref No.: 9585-001-02 Revision No.: 00 Date: **05.04.2017**

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						KOLHAPUR STEELS	KOLHAPUR	DR			
						JSC ENERGOMASH	UKRAIN	DR			
29	INTERMEDIATE PIECE VALVE COVER & CHAMBER	I	QVM-Q-308			SANDE-STAHL	GERMANY	A			
						VOIST ALPINE	AUSTRIA	A			
						CFFP	HARDWAR	A			
						UP STEELS	MUZAFFARNAGAR	A			
						STARWIRE	BALLABGARH	A			
						KOLHAPUR STEELS	KOLHAPUR	A			
						PRAKASH SPECTRO	VIJAYAWADA	DR			
30	GUIDE BLADE CARRIER										
		I	QVM-Q-308			VOIST ALPINE	AUSTRIA	A			
		I				SANDE STAHLGUSS GMBH,	GERMANY	A			
		I				STAR WIRES	BALLABGARH	A			
		I				KOLHAPUR STEEL	KOLHAPUR	A			
		I				KCP	CHENNAI	A			
		I				PRAKASH SPECTRO	VIJAYAWADA	DR			
		I				UP STEELS	MUJAFARNAGAR	A			
31	STEAM CHAMBER	I	QVM-Q-308			VOIST ALPINE	AUSTRIA	A			
		I				CFFP	HARDWAR	A			
		I				KOLHAPUR STEEL	KOLHAPUR	DR			
		I				SANDESTAHI	GERMANY	A			
		I				UP STEELS	MUJAFARNAGAR	A			
		I				UTOSTROJ STEEL	GERMANY	A			
32	ROTOR FORGINGS (TURBINE)	I	QVM-Q-308			CFFP	HARDWAR	A			
		I				SAAR SCHMIED	GERMANY				
		I				SDF	ITALY	A			

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		I				EDELSTAHLWERKE	GERMANY	A			
		I				GROEDITZ	GERMANY	DR			
		I				PILSON STEEL (VHS,SKODA)	CZECKSLOVAKIA	A			
		I				JCFC	JAPAN	A			
		I				JSC ENERGOMASH	UKRAIN	DR			
		I				JSW	JAPAN	A			
		I				KOBE STEEL	JAPAN	A			
		I				CRUIST FORGE	FRANCE	A			
33	PRECISION BLADE FORGINGS	I	QVM-Q-308			PETRO ROSA	GERMANY	A			
		I				FINE FORGE	HYDERABAD	A			
		I				C BLADE	ITALY	A			
		I				WUXI	CHINA	A			AS PER NTPC APPROVAL CONDITIONS
		I				AZAD ENGG	HYDERABAD	A			FOR MACHINING ONLY
34	BAR STOCK FOR BLADES	I	QVM-Q-308			WALZWERK EINSL	GERMANY	A			
		I				BOEHLER	AUSTRIA	A			
		I				BGH	GERMANY	A			
		I				BREITENFIELD	AUSTRALIA	A			
		I				STARWIRE	BALLABHGARH	A			
35	DRAWN PROFILE FOR GUIDE BLADES (DRIVE TURBINE)	I	QVM-Q-308			FIAV	ITALY	A			
		I				LEISTRITZ	GERMANY	A			
		I				BOEHLER	AUSTRIA	A			
36	GEAR BOX	I	QVM-Q-308			TRIVENI ENGG	MYSORE	A			
		I				FLENDER GRAFFENSTADEN	FRANCE	A			

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		I				LUFKIN	USA/FRANCE	A#			
		I				RENK TACKE GMBH	GERMANY	A#			
		I				WALCHANDNAGAR	PUNE	A#			
						WINENERGY	CHENNAI	DR			
37	DRIVE TURBINE	I	QVM-Q-308			BHEL	HYDERABAD	A			
38	CONNECTING COUPLING (GEAR TYPE) CONNECTING COUPLING (MEMBRANE)	I	QVM-Q-308			RENK TACKE GMBH	GERMANY	A			
		I				LUFKIN	USA/FRANCE	A			
		I				FLENDER	GERMANY	A			
		I				WALCHANDNAGAR	WALCHANDNAGAR	A			
		I	QVM-Q-308			EUROFLEX LTD.,	HYDERABAD	A			
		I				JOHN CRANE	UK	A			
		I				AMERDRIVES	USA	A			
						RATHI TURBOFLEX	PUNE	A			
39	AUX. CONTROL VALVE BODY & COVER	I	QVM-Q-309			CFFP	HARDWAR	A			
		I				KOLHAPUR STEELS	KOLHAPUR	A			
		I				UP STEELS	MUJAFARNAGAR	A			
		I				STAR WIRES	BALLABGARH	A			
						PRAKASH SPECTRO	VIJAYAWADA	DR			
40	LUBE OIL CENTRIFUGAL PUMP	II	QVM-Q-310			KSB	PUNE	A			
		II				KIRLSOKAR EBARA	KIRLOSKARWADI	A			
		II				SULZER	MUMBAI	A			
41	LUBE OIL PUMP (SCREW PUMP)	II	QVM-Q-311			ALLWEILER	GERMANY	A			
		II				TUSHACO PUMP	DAMAN	A			
		II				LEISTRITZ	GERMANY	A			
		II				IMOPUMP	USA	A			
42	DISCONNECTING COUPLING	II	QVM-Q-312			AMER DRIVES	USA	A			
43	CENTRIFUGE	I	QVM-Q-313			ALFALAVAL	PUNE/SWEDEN	A			

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		I				WEST FALIA INDIA	BANGALORE	A			
44	JOP	II				TUSHACO PUMP	DAMAN	A			
		II				DYNAMIC TECHNOLOGIES	BANGALORE	DR			
		II				ALLWEILER	GERMANY	A			
45	FOUNDATION FRAME FOR BFP, BP & DRIVE TURBINE & MOTOR	I				BHEL	HYDERABAD	A			
46	LUBE OIL SYSTEM	I				BHEL	HYDERABAD	A			
47	OIL COOLERS	I				BHEL	HYDERABAD	A			
48	TUBE SHEET FORGING (HP HEATER)	I				*M/s RINGMILL S.P.A.,*	*ITALY*	A			
		I				*M/s FORGIATURA MORANDINI SRL,*	*ITALY*	A			
		I				*M/s FORGE MONCHIERI S.R.L.*	*ITALY*	A			
		I				*M/s TAEWOONG COMPANY LIIMITED*	*KOREA*	A			
		I				*M/s BAY-FORGE LIMITED,*	*CHENNAI*	DR			
		I				*M/s CFFP*	*HARDWAR*	A			
49	STEEL FORGING (OTHER THAN H.P HEATER TUBE SHEETS)	II				*M/s GOLDEN IRON & STEEL WKS.*	*DELHI*	A			
		II				*M/s THE PUNJAB STEEL WORKS,*	*DELHI*	A			
		II				*M/s ACME FORGINGS PVT LTD.,*	*RAJKOT*	A			
		II				*M/s CHAUDHRY HAMMER WORKS (P)*	*GHAZIABAD*	A			

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						LTD.					
		II				*M/s GHAZIABAD ISPAT UDYOG LTD.,*	*GHAZIABAD*	*A*			
		II				*METAL FORGING*	*DELHI*	*DR*			
		II				*SANGHVI FORGING & ENGINEERING*	*BARODA*	*DR*			
		II				*C.D.Industries*	*GHAZIABAD*	*DR*			
		II				*KISSAN DIE-TECH*	*GHAZIABAD*	*DR*			
		II				*CHW Forge Private Limited*	*GHAZIABAD*	*DR*			
50	HEMI HEAD	I				M/s VOEST ALPINE GIESSEREI LINZ GMBH,LTD.,	GERMANY	A			
		I				M/s EDMONTON EXCHANGER & MFG.LTD.,	CANADA	A			
		I				M/s DILLING-GTS VENTES,	GERMANY	A			
		I				M/s CEREC,	FRANCE	A			
		I				M/s CEREC,	VADODARA	DR			
		I				M/s KONIG & CO. GMBH,	GERMANY	A			
		I				M/s ANTONIUS VESSEL HEADS B.V.,	FRANCE	DR			
		I				M/s RICHARDSON & CRUDDAS (1972) LTD.,	MUMBAI	A			
		I				M/s J BOWN & CO.(DUKINFIELD) LIMITED	U.K				

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एनटीपीसी NTPC	Project : PATRATU STPP(3X800MW) Package : EPC Contractor : BHEL, Hyderabad Contract No.:	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUBCONTRACTOR APPROVAL SUB SYSTEM: **BFP, Drive Turbine, Heaters (HP, LP) Drain Cooler and Deaerator**	Ref No.: 9585-001-02 Revision No.: 00 Date: **05.04.2017**

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						STEEL FORCE	BELGIUM	DR			
						MAHENDRA DISHED ENDS	***THANE***	***DR***			
						ICEM ENGINEERING PVT LTD	***THANE***	***DR***			
						GEUM CHANG HEAD CO	***KOREA***	***DR***			
51	DISHED ENDS	I				M/s DYNAMIC DISH INDIA (PVT) LTD.,	HYDERABAD	DR			
		I				M/s METAL ENGINEERS,	HYDERABAD	A			
		I				M/s SATYA FABRICATORS PVT LTD.,	HYDERABAD	A			
		I				MAHENDRA DISH ENDS	THANE	DR			
		I				M/s CEREC,	FRANCE	A			
		I				M/s CEREC,	VADODARA	DR			
		I				M/s THE ANUP ENGINEERING LTD	INDIA	A			
		I				M/s KONIG & CO. GMBH,	GERMANY	A			
		I				M/s ICEM ENGEENING COMPANY LTD.	THANE	DR			
52	SMALL FORGING	II				M/s GOLDEN IRON & STEEL WKS.	DELHI	A			
		II				M/s THE PUNJAB STEEL WORKS,	DELHI				
		II				M/s ACME FORGINGS	RAJKOT				

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						PVT LTD.,					
		II				M/s CHAUDHRY HAMMER WORKS (P) LTD.	GHAZIABAD	A			
		II				M/s GHAZIABAD ISPAT UDYOG LTD.,	GHAZIABAD	A			
		II				METAL FORGING	DELHI	DR			
		II				*SANGHVI FORGING & ENGINEERING*	*BARODA*	DR			
		II				*C.D.Industries*	*GHAZIABAD*	DR			
		II				*KISSAN DIE-TECH*	*GHAZIABAD*	DR			
		II				*CHW Forge Private Limited*	*GHAZIABAD*	DR			
53	STAINLESS STEEL TUBE (STRAIGHT) WELDED	*I*				*M/s. Neotiss Limited (formerly VALLOUREC HEAT EXCHANGER TUBES LTD.,)*	*HYDERABAD*	*A*			FOR LP HEATER ONLY
		I				*M/s RATNADEEP METAL&TUBES P.LTD*	*AHMEDABAD*	*A*			FOR LP HEATER ONLY
		I				*M/s RATNAMANI METALS & TUBES LTD.,*	*AHMEDABAD/ KUTCH*	*A*			
		I				*M/s HEAVY METAL & TUBES LIMITED,*	*AHMEDABAD*	*A*			
		I				*M/s REMI*	*TARAPUR*	*A*			FOR LP HEATER ONLY
		I				*M/s PLYMOUTH TUBE COMPANY,*	*USA*	*A*			
54	STAINLESS STEEL TUBE (U TUBE) WELDED (ABOVE 17	I				M/s RATNAMANI METALS & TUBES	AHMEDABAD/ KUTCH				

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Patratu Vidyut Utpadan Nigam Limited C & M Deptt.

BHEL HYD

एनटीपीसी NTPC	Project : PATRATU STPP(3X800MW) Package : EPC Contractor : BHEL, Hyderabad Contract No.:	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUBCONTRACTOR APPROVAL SUB SYSTEM: BFP, Drive Turbine, Heaters (HP, LP) Drain Cooler and Deaerator	Ref No.: 9585-001-02 Revision No.: 00 Date: 05.04.2017

SN	ITEM	QP/ INS-PN CAT *	QP No. xxxx-110	QP SUB-MISSION SCHEDULE	QP APPL SCHEDULE	PROPOSED SUB SUPPLIER	PLACE	SS APPL STATUS / CAT	SS DETAIL SUB-SCHEDULE	SC APPL SCHEDULE	REMARKS
	BWG)					LTD.,					
		I				*M/s. Neotiss Limited (formerly VALLOUREC HEAT EXCHANGER TUBES LTD.,)*	*Patancheru, Hyderabad*	*DR*			
		I				*M/s. REMI*	*Tarapur*	*DR*			
		I				*M/s. Shinhan Metal*	*South Korea*	*DR*			
		I				M/s PLYMOUTH TUBE COMPANY,	USA	A			
55	STAINLESS STEEL TUBE (U TUBE) WELDED (UP TO 17 BWG)	I				M/s RATNAMANI METALS & TUBES LTD.,	AHMEDABAD/ KUTCH	A			
		I				M/s PLYMOUTH TUBE COMPANY,	USA	A			
		I				M/s VALLOUREC HEAT EXCHANGER TUBES LTD. (FORMERLY CST VALINOX)	HYDERABAD	A			
		I				REMI	TARAPUR	DR			
		I				SHINHAN	KOREA	DR			
56	SAFETY RELIEF VALVE (TUBE SIDE AND SHELL SIDE)	I				M/s TYCO	USA	A			
		I				M/s DRESSER	USA	A			
		I				*M/FAINGER LESSER*	*GERMANY*	*A*			
		I				*BHEL-HPBP-TRICHY*	*TRICHY*	*DR*			
		I				*PENTAIR VALVES & CONTROLS*	*VADODARA*	*DR*			
		I				*KSB MIL CONTROL LIMITED*	*CHENNAI*	*DR*			

Bharat Heavy Electricals Limited * PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited * Distt-Ramgarh (Jharkhand) C & M Deptt. BHEL

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BHEL HYD

एनटीपीसी NTPC	Project : PATRATU STPP(3X800MW) Package : EPC Contractor : BHEL, Hyderabad Contract No.:	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUBCONTRACTOR APPROVAL SUB SYSTEM: **BFP, Drive Turbine, Heaters (HP, LP) Drain Cooler and Deaerator**	Ref No.: 9585-001-02 Revision No.: 00 Date: **05.04.2017**

SN	ITEM	QP/ INS-PN CAT *	QP No. xxxx-110	QP SUB-MISSION SCHEDULE	QP APPL SCHEDULE	PROPOSED SUB SUPPLIER	PLACE	SS APPL STATUS / CAT	SS DETAIL SUB-SCHEDULE	SC APPL SCHEDULE	REMARKS
		I				*ASIAN INDUSTRIAL VALVES AND INSTRUMENTS*	*CHENNAI*	*DR*			
57	LP HEATER	I				*BHEL*	*HYDERBAD*	*A*			SUB-QR ITEM
58	HP HEATER	I				*BHEL*	*HYDERBAD*	*DR*			SUB-QR ITEM
		I				SPX	USA	A			SUB-QR ITEM
		I				BHI	SOUTH KOREA	A			SUB-QR ITEM
		I				TEI	USA	A			SUB-QR ITEM
		I				SHANGHAI	CHINA	A			SUB-QR ITEM
		I				HOLTEC	USA	A			SUB-QR ITEM
59	DRAIN COOLER	I				BHEL	HYDERBAD	A			
60	VALVES GATE, GLOBE, CHECK ½ TO 10" (UPTO 2500 CL)	II				TOA VALVES	JAPAN	A			
		II				DEUTSCHE BABCOCK	GERMANY	A			
		II				DRESSER	USA	A			
		I				BHEL	TRICHY	A			
		I				*FLOSTEER ENGINEERS PVT. LTD.,*	*AHMEDABAD*	*DR*			
		I				*JOSHIJAMPALA ENGINEERING PRIVATE LI*	*SATARA*	*DR*			
		I				*SKILT FABRICATORS PVT.LTD,*	*MUMBAI*	*DR*			
		I				*VALVE TECH INDUSTRIES*	*NAVI MUMBAI*	*DR*			
		I				*CHEMTECH INDUSTRIAL VALVES*	*THANE*	*DR*			
61	VALVES (GATE, GLOBE, NRV) ½ TO 10" FOR LP	I				L&T	CHENNAI/COIMBATORE				

Bharat Heavy Electricals Limited ★ PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited ★ Distt-Ramgarh(Jharkhand) C & M Deptt.

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BHEL HYD

एनटीपीसी NTPC	Project : PATRATU STPP(3X800MW) Package : EPC Contractor : BHEL, Hyderabad Contract No.:	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUBCONTRACTOR APPROVAL SUB SYSTEM: BFP, Drive Turbine, Heaters (HP, LP) Drain Cooler and Deaerator	Ref No.: 9585-001-02 Revision No.: 00 Date: 05.04.2017

SN	ITEM	QP/ INS-PN CAT *	QP No. xxxx-110	QP SUB-MISSION SCHEDULE	QP APPL SCHEDULE	PROPOSED SUB SUPPLIER	PLACE	SS APPL STATUS / CAT	SS DETAIL SUB-SCHEDULE	SC APPL SCHEDULE	REMARKS
	APPLICATIONS	I				BHEL	TRICHY	A			
		I				FOURESS	AURANGABAD	A			Up to 2"x800# Upto 10x600#
		I				WEIR BDK	HUBLI	A			Up to 2"x800# Upto 10x600#
		I				*FLOSTEER ENGINEERS PVT. LTD.,*	*AHMEDABAD*	DR			
		I				*JOSHIJAMPALA ENGINEERING PRIVATE LI*	*SATARA*	DR			
		I				*SKILT FABRICATORS PVT.LTD,*	*MUMBAI*	DR			
		I				*VALVE TECH INDUSTRIES*	*NAVI MUMBAI*	DR			
		I				*CHEMTECH INDUSTRIAL VALVES*	*THANE*	DR			
62	CCS GLOBE VALVES UPTO 300 NB AND 150 CLASS	I				KBL	KONDAPURI	A			
		I				FOURESS ENGG	AURANGABAD	A			
		I				WEIR BDK	HUBLI	A			
		I				KSB	COIMBATORE	A			
		I				LEADER ENGG	JALLANDHAR	A			
		I				SKILT	MUMBAI	DR			
		I				BHEL	TRICHY	A			
		I				*FLOSTEER ENGINEERS PVT. LTD.,*	*AHMEDABAD*	DR			
		I				*JOSHIJAMPALA ENGINEERING PRIVATE LI*	*SATARA*	DR			
		I				*VALVE TECH*	*NAVI MUMBAI*	DR			

Bharat Heavy Electricals Limited PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited G & M Deptt.

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SN	ITEM	QP/ INS-PN CAT *	QP No. xxxx-110	QP SUB-MISSION SCHEDULE	QP APPL SCHEDULE	PROPOSED SUB SUPPLIER	PLACE	SS APPL STATUS / CAT	SS DETAIL SUB-SCHEDULE	SC APPL SCHEDULE	REMARKS
						INDUSTRIES					
		I				*CHEMTECH INDUSTRIAL VALVES*	*THANE*	DR			
63	DEARATOR	I				BHEL	HYDERABAD	A			SUB-QR ITEM
	# FABRICATOR BASED ON BHEL HYD DESIGN					#BHEL	VISHAKAPATNAM	DR			
						#VRK	HYDERABAD	DR			
						#Thandav Lakshmi Engineering works	VISHAKAPATNAM	DR			
						# Jay Engg	Trichy	DR			
						# Sai Sarag	Hyderabad	DR			
						# Premier Engg	Hyderabad	DR			
64	DEARATOR SPRAY VALVES	III				NEWTERA (COCHRANE ENVIRONMENTAL SYSTEM (CRANE))	USA	A			
		III				STERLING	USA	A			
		III				KCD	USA	DR			
		I				VALUE TREK ENGINEERS	HYDERABAD	DR			
		I				VIJAYA TOOLING ENGINEERS	HYDERABAD	DR			
65	DEARATOR TRAY ASSEMBLY	III				NEWTERA (COCHRANE ENVIRONMENTAL SYSTEM (CRANE))	USA	A			
		III				STERLING	USA	A			
		III				KCD	USA	DR			
		I				VRK INDUSTRIES	HYDERABAD	DR			
		I				PREMIER ENGG	HYDERABAD	DR			

Bharat Heavy Electricals Limited PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited * Distt-Ramgarh (Jharkhand) C&M Deptt.

एनटीपीसी NTPC	Project : PATRATU STPP(3X800MW) Package : EPC Contractor : BHEL, Hyderabad Contract No.:	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUBCONTRACTOR APPROVAL SUB SYSTEM: **BFP, Drive Turbine, Heaters (HP, LP) Drain Cooler and Deaerator**	Ref No.: 9585-001-02 Revision No.: 00 Date: **05.04.2017**

SN	ITEM	QP/ INS-PN CAT *	QP No. xxxx-110	QP SUB-MISSION SCHEDULE	QP APPL SCHEDULE	PROPOSED SUB SUPPLIER	PLACE	SS APPL STATUS / CAT	SS DETAIL SUB-SCHEDULE	SC APPL SCHEDULE	REMARKS
		I				VALUE TREK	HYDERABAD	DR			
		I				Pavan Engg	Hyderabad	DR			
		I				VIJAY TOOLING	HYDERABAD	DR			
66	LT MOTORS UPTO 200 KW(REFER NOTE-1)	I				BHARAT BIJLEE	MUMBAI	A			UPTO 160KW
		I				KEC	BANGALORE/ HUBLI*	A			* UPTO 90 KW
		I				MARATHON	KOLKATA	A			
		I				CGL	AHMEDNAGAR	A			
		I				ABB	FARIDABAD*/ BANGALORE	A			* UPTO 55 KW
						LAXMI HYDRAULICS	SOLAPUR	A			* UPTO 120 KW
						SIEMENS INDIA	*INDIA*	DR			
67	SAFETY RELIEF VALVE	I				*BHEL,*	*TIRICHY*	A			
						PENTAIR VALVES & CONTROLS	*VADODARA*	DR			
						KSB MIL CONTROL LIMITED	*CHENNAI*	DR			
						ASIAN INDUSTRIAL VALVES AND INSTRUMENTS	*CHENNAI*	DR			

A- Proposed vendor is acceptable to NTPC, N: BHEL/ MHI approved vendors indicated as "N" are accepted in NOTED category by NTPC for this project based on BHEL/MHI experience with the vendor for the items & DR – "Details required" for NTPC review.

2 QP/INSPECTION CATEGORY:

CAT – I : For those items the Quality Plans are approved by NTPC and final acceptance will be on physical inspection witness by NTPC.

CAT – II : For those items the Quality Plans are approved by NTPC. However no physical inspection shall be done by NTPC. The final acceptance by NTPC shall be on the basis of review of documents as per QP.

CAT-III : For those items main supplier approves Quality Plan. The final acceptance by NTPC shall on the basis of Certificate of Conformance by main supplier.

Bharat Heavy Electricals Limited PS-MKTG Delhi
Patratu Vidyut Utpadan Nigam Limited C & M Dept. Distt-Ramgarh(Jharkhand)

एनटीपीसी NTPC	Project : PATRATU STPP(3X800MW) Package : EPC Contractor : BHEL, Hyderabad Contract No.:	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUBCONTRACTOR APPROVAL SUB SYSTEM: BFP, Drive Turbine, Heaters (HP, LP) Drain Cooler and Deaerator	Ref No.: 9585-001-02 Revision No.: 00 Date: 05.04.2017

SN	ITEM	QP/ INS-PN CAT *	QP No. xxxx-110	QP SUB-MISSION SCHEDULE	QP APPL SCHEDULE	PROPOSED SUB SUPPLIER	PLACE	SS APPL STATUS / CAT	SS DETAIL SUB-SCHEDULE	SC APPL SCHEDULE	REMARKS

NOTE 1: a) Less than 30 KW

Acceptance of Motor less than 30 KW is based on COC of the manufacturer & the contractor confirming as follows:

It is hereby confirmed that the above mentioned motor /motors was/ were manufactured taking care of NTPC specific requirements regarding ambient temp., voltage & frequency variation, hot starts, pull out torque, starting KVA/KW, temp. rise, distance between centre of stud & gland plate and tested in accordance with approved drawing /data sheets.

b) 30 KW and above

Acceptance of Motor rating between 30 KW & 50 KW is based on NTPC review of Routine Test inspection report as per IS 325 by main contractor along with COC of the manufacturer & the contractor confirming as follows:

« It is hereby confirmed that the above mentioned motor /motors was/ were manufactured taking care of NTPC specific requirements regarding ambient temp., voltage & frequency variation, hot starts, pull out torque, starting KVA/KW, temp. rise, distance between centre of stud & gland plate, space heater and tested in accordance with approved drawing /data sheets.

FOR HT MOTORS REFER SEPARATE VENDOR LIST FINALIZED FOR BHEL BHOPAL.

NOTE 2 : IF BOOSTER PUMPS SHAFT AND CEP SHAFT ARE MADE FROM ROLLED BARS THEN VENDORS SHALL BE AS PER BHEL APPROVED VENDOR LIST.

NOTE 3 : FOR VALVES OF SIZE ½ INCH AND BELOW SHALL BE PROCURED FROM BHEL APPROVED SOURCES.

Bharat Heavy Electricals Limited ★ PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited ★ Dist.-Ramgarh(Jharkhand) C & M Deptt. BHEL

NTPC	PROJECT:	: PATRATU EPC (3X			LIST OF ITEMS REQUIRING QUALITY PLAN		PACKAGE:	EPC
							SUB-PKG.:	
	CONTRACTOR:	BHEL-PEM					REV. NO.	00
	CONTRACT NO.:	9585-001-2					DATE:	12.04.2017
Sl. NO.	ITEM	QP_ CAT	QP_NO	QP_SCH	PROPOSED SUB_SUPPLIER	PLACE	APPRL_STA TUS/ CAT	REMARK
1.00	LUBE OIL PUMP	I			MATZ ENGINEERS	AHEMDABAD	A	
		I			Delta PD Pumps Pvt.Ltd.	Vapi	DR	
		I			Del Pd Pumps & Gears	Surandenagar,Gujarat	DR	
		I			TUSHACO PUMPS	DAMAN	A	
2.00	SELF CLEANING STRAINER	I			MULTITEX	NOIDA	A	
		I			GEA BGR ENERGY SYSTEM	CHENNAI	A	
		I			FILTERATION ENGINEERS (I) PVT.	MUMBAI	DR	Approved upto 800 NB size
3.00	GM VALVES (UPTO 100 NB)	III			BHEL APPROVED SOURCES			VENDOR APPROVAL BY NTPC NOT ENVISAGED.
4.00	METELLIC BELLOWS	I			Qinhuangdao North Metal Hose Co. Ltd.,	CHINA	DR	
		I			FLEXICON BELLOWS & HOSES	BARODA	A*	A* AS PER APPROVAL CONDITIONS
		I			LONESTAR INDUS.	CHENNAI	A*	A* AS PER APPROVAL CONDITIONS
		I			MB METTALIC BELLOWS (I) P LTD	CHENNAI	A*	A* AS PER APPROVAL CONDITIONS
		I			METTALIC BELLOWS (I) P LTD	CHENNAI	A*	A* AS PER APPROVAL CONDITIONS
					FLEXATHERM EXPANLLOW PVT.	VADODARA	DR	
					BD ENGINEERING	AHMEDABAD	DR	
		I			TEDDINTON ENGINEERED	UK	DR	
5.00	THERMAL INSULATION (ROCKWOOL MATRESSES/ P-	I			Minsulate Manufacturing Co.	Jamshedpur	DR	
		I			GOENKA Rockwool	RAIPUR	A	
		I			LLOYD INSULATION (I) LTD	BHILAI,JAMSHEDPUR, AURANGABAD	A	
		I			ROCKWOOL INDIA	MEDAK , AP	A	
		I			THERMOCARE ROCKWOOL INDIA	RAJNANDGAON	DR	

Bharat Heavy Electricals Limited ★ PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited ★ Distt-Ram... ★ (Jharkhand) C & M Deptt.

(NILESH KAMAL) BHEL-PEM

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NTPC	PROJECT:	: PATRATU EPC (3X			LIST OF ITEMS REQUIRING QUALITY PLAN		PACKAGE:	EPC
							SUB-PKG.:	
	CONTRACTOR:	BHEL-PEM					REV. NO.	00
	CONTRACT NO.:	9585-001-2					DATE:	12.04.2017
SI. NO.	ITEM	QP_CAT	QP_NO	QP_SCH	PROPOSED SUB_SUPPLIER	PLACE	APPRL_STATUS/ CAT	REMARK
		I			SHREERAM EQUITECH PRIVATE	DURG	DR	
		I			Polybond Insulation Private Limited,	BHILAI	DR	
		I			Dhanbad Rockwool Insulation Pvt.Ltd.	Dhanbad	DR	
		I			Hitec Rockfibre Pvt.Ltd.	RAJNANDGAON	Dr	
6.00	BALL VALVES (NON FIRE SAFE TYPE)	I			MICROFINISH VALVES	HUBLI	A	UPTO 400NB, #300
		I			VAAS AUTOMATION	CHENNAI	DR	
		I			BELGAUM AQUA VALVES PVT. LTD.	BELGAUN	A	50 NB CLASS 800 200NB CLASS 150
		I			A.V. VALVES LTD	AGRA	DR	
		I			ATAM VALVES PVT. LTD.	JALANDHAR	DR	
		I			VALTECH INDUSTRIES	MUMBAI	DR	
		I			M/S GM ENGINEERING	RAJKOT	DR	
		I			INTERVALVE (INDIA) LTD.	PUNE	DR	
		I			DEMBLA VALVES LTD.	THANE	DR	
		I			UNIFLOW	CHENNAI	DR	
		I			WEIR BDK	HUBLI	A	UPTO 400 NBX150#
		I			LEADER	JALANDHAR	A	UPTO50MM-CLASS800, CCS-50TO100MM-CLASS 150
		I			NILON VALVES PRIVATE LTD	AHMEDABAD	DR	
		I			HAWA VALVES (IDIA) PVT. LTD.	NAVI MUMBAI	DR	
		I			HAWA ENGINEERS	AHMEDABAD	DR	
		I			CRESCENT VALVES	AHMEDABAD	DR	
		I			MICON VALVES	MUMBAI	DR	
		I			MEVADA ENGINEERING	MUMBAI	DR	

Bharat Heavy Electricals Limited PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited C & M Deptt. Distt-Ramgarh(Jharkhand)

NTPC	PROJECT:	: PATRATU EPC (3X			LIST OF ITEMS REQUIRING QUALITY PLAN		PACKAGE:	EPC
							SUB-PKG.:	
	CONTRACTOR:	BHEL-PEM					REV. NO.	00
	CONTRACT NO.:	9585-001-2					DATE:	12.04.2017
SI. NO.	ITEM	QP_CAT	QP_NO	QP_SCH	PROPOSED SUB_SUPPLIER	PLACE	APPRL_STATUS/ CAT	REMARK
		I			DELVAL FLOW CONTROLS	SATARA	DR	
7.00	STEAM TRAPS	III			BHEL APPROVED SOURCES			VENDOR APPROVAL BY NTPC NOT ENVISAGED.
8.00	AIR TRAPS	III			BHEL APPROVED SOURCES			VENDOR APPROVAL BY NTPC NOT ENVISAGED.
9.00	BUTTERFLY VALVES (STEAM SERVICES)	I			FOURESS ENGG.	BANGALORE	A	UPTO 2600NB
		I			NENGFA WEIYE TIELING VALVE JOINT STOCK CO. LTD.	CHINA	DR	
		I			IL	PALGHAT	A	UPTO 2200NB
		I			SHENJIANG VALVES CO.	CHINA	DR	
10.00	AIR RELEASE VALVES	III			BHEL APPROVED SOURCES			BHEL APPROVED SOURCES
11.00	CHEMICAL DOSING (LP)	I			TECHNO CONSULTANT	MUMBAI	A	
		I			SWELLORE	AHEMDABAD	A	
		I			VK PUMPS	NASHIK	A	
		I			POWER PIPING COMPANY	Trichy	A	
		I			PSI	CHENNAI	A	

Bharat Heavy Electricals Limited ★ PS-MKTG Delhi

★ Patratu Vidyut Utpadan Nigam Limited ★ Distt-Ramgarh(Jharkhand) C & M Deptt.

NTPC	PROJECT:	: PATRATU EPC (3X			LIST OF ITEMS REQUIRING QUALITY PLAN		PACKAGE:	EPC
							SUB-PKG.:	
	CONTRACTOR:	BHEL-PEM					REV. NO.	00
	CONTRACT NO.:	9585-001-2					DATE:	12.04.2017
Sl. NO.	ITEM	QP_CAT	QP_NO	QP_SCH	PROPOSED SUB_SUPPLIER	PLACE	APPRL_STATUS/ CAT	REMARK
		I			ENPRO INDUSTRIES PVT.LTD.	PUNE	DR	
		I			ROCKWIN FLOWMWTER INDIA PVT LTD	GHAZIABAD	DR	
		I			POSITIVE METERING PUMPS (I) PVT. LTD.	NASIK	A	
		I			TECNO STRENGTH PVT.LT.	HYDERABAD	DR	
		I			MR SYSTEMS	HOWRAH	DR	
12.00	COLTCS(Not Applicable)							
13.00	SPRING LOADED BYPASS VALVE	I			WEIR VALVES & CONTROLS UK LTD.	U.K.	A	UP TO NB 450, 2000#
		I			SEMPELL GmbH	GERMANY	A	UP TO NB 450, 2260#
		I			STRACK GmbH,	GERMANY	A	UP TO NB 450, 4500#
		I			BHEL -Trichy Valves	Trichy	DR	
14.00	ALUMINIUM SHEET /COILS	III			NATIONAL ALUMINIUM COMPANY LTD.	BHUBNESHWAR	N	
		III			BHARAT ALUMINIUM COMPANY LTD	DELHI	N	
		III			HINDALCO INDUSTRIES LTD	MUMBAI	N	
		III			Jindal Aluminium	Bangalore	DR	
		III			CHONGGING LANREN ALUMINIUM CO. LTD.	CHINA	DR	
15.00	THERMAL INSULATION CERAMIC FIBRE	I			LLOYD INSULATIONS (INDIA) LTD.	NALAGARH BADDI	DR	
		I			Simond Fibre Tech Ltd.	Rajkot	DR	
		I			Sri Ceramic Fibre Pvt.Ltd.	Indore	DR	
		I			UNIFRAX INDIA	LAKHTAR	DR	

Bharat Heavy Electricals Limited ★ PS-MKTG Delhi

C & M Deptt.

0	PROJECT: PATRATU (3 X 800 MW)				NTPC DOC NO:	CS-9585-001-2	
NTPC	SUB-PACKAGE:EPC SUB-PACKAGE:	LIST AND STATUS OF ITEM REQUIRING QP AND SUB-SUPPLIER APPROVAL			REV. NO.	0	
	MAIN SUPPLIER: BHEL				DATE	12.04.2017	
	CONTRACT NO.: CS-9585-001-2	SUB SYSTEM: ERECTION CONTRACTORS			ANNEXURE		
SR. NO.	ITEM	QAP / INSP. CAT	QAP NO.	PROPOSED SUB SUPPLIER	PLACE OF MANUFACTURING	APPROVAL STATUS	REMARKS
1	TG & AUX INCLUDING GENERRATOR	I		LARSEN & TOUBRO	MUMBAI	A	NOTE-1
		I		POWER MECH	VIJAYWADA	A	NOTE-1
		I		INDWELL CONSTRUCTIONS LTD	VIJAYWADA	A	NOTE-1
		I		BROTHERS ENGINEERS	CHENNAI	A	NOTE-1
		I		PE ERECTORE	KOLKATA	A	NOTE-1
		I		ALSTOM POWER INDIA LTD	DELHI	A	NOTE-1
		I		TATA PROJECTS LTD	HYDERABAD	A	NOTE-1
		I		UNIVERSAL ERECTORS	MUMBAI	A	NOTE-1
		I		BSES LTD	MUMBAI	A	NOTE-1
		I		ENGINEOUS ERECTORS	CHENNAI	A	NOTE-1
		I		SPIC GEL	CHENNAI	A	NOTE-1
		I		VABSUN ERECTORS	HYDERABAD	DR	NOTE-1
		I		DPC ENGINEERING PROJECTS	CHENNAI	DR	NOTE-1
		I		RELIANCE INFRASTRUCTURE	MUMBAI	DR	NOTE-1
		I		SUNIL HI TECH	NAGPUR	A	NOTE-1
		I		VASAVI POWER SERVICES LTD	HYDERABAD	DR	NOTE-1
		I		TEXCEL	CHENNAI	A	NOTE-1
		I		MACWELL CONSTRUCTIONS	VIJAYWADA	DR	NOTE-1
		I		UNIVERSAL ERECTORS	AHMEDABAD	DR	NOTE-1
		I		EDAC ENGINEERS	CHENNAI	DR	NOTE-1
		I		KARPARA PROJECT ENGG	SURAT	DR	NOTE-1
		I		PCP INTERNATIONAL	CHANDIGARH	DR	NOTE-1
		I		UB ENGINEERING	PUNE	DR	NOTE-1
				MECH ENGINNERS & ERECTORS	TELANGANA	DR	NOTE-1
		I		ALPHA	JAMNIPALI	DR	NOTE-1
		I		ESSAR PROJECTS (I) LTD.	MUMBAI		NOTE-1
2	GENERATOR & AUXLILIARIES	I		SAME AS SL. NO. 1			

Bharat Heavy Electricals Limited PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited C & M Deptt. Dist. Ramgarh (Jharkhand)

G.V. Rajeev 12/04/17

SR. NO.	ITEM	QAP / INSP. CAT	QAP NO.	PROPOSED SUB SUPPLIER	PLACE OF MANUFACTURING	APPROVAL STATUS	REMARKS
3	C&I OF ST & TG	I		NOTE-2			
4	HP PIPING	I		NOTE-2			
5	LP PIPING	I		NOTE-2			
6	BOILER FEED PUMP	I		NOTE-2			
7	HEATERS, DEAERATORS	I		NOTE-2			
8	CEP	I		NOTE-2			
9	HT MOTORS	I		NOTE-2			
10	CRANES-EOT & MISC	I		NOTE-2			
11	PASSANGER CUM GOODS ELEVATOR	I		NOTE-2			
12	TANKS & VESSELSCABLING	I		NOTE-2			
		I		NOTE-2			
13	DC SYSTEM 220/24 V - BATTERY	I		NOTE-2			
14	BATTERY CHARGER	I		NOTE-2			
15	HYDROGEN GENERATION PLANT	I		NOTE-2			

NOTE-1: Additional sub-contractors may be considered as per MOM provision. Organizational, financial and technical aspects will be taken care by BHEL before award of the jobs to the sub-contractors. Mobilisation of manpower, tools , tackles to suit the requirements of the job schedule shall be tied up by BHEL in consultation with NTPC site before award for which the details of sub-contractors shall be forwarded to GM-Site.

NOTE-2: BHEL approved sub-contractors for erection - would mean NTPC approval not required. However, mobilisation of manpower, tools , tackels to suit the requirements of the job schedule shall be tied up by BHEL in consultation with NTPC site.

NOTE-3: BHEL will follow their standared procedure, corporate guidelines and shall comply with circulars/ instructions etc. issued by Government/ relevant statutory bodies while tendering. However for new vendor, BHEL shall take approval from NTPC prior to order placement.

Bharat Heavy Electricals Limited ★ PS-MKTG Delhi

★ Patratu Vidyut Utpadan Nigam Limited ★ Distt-Ramgarh(Jharkhand) C & M Deptt.

G.V.Rajasekhar 12/04/17
(G.V.RAJASEKHAR)
(BHEL-PSNR)

एनटीपीसी NTPC	PROJECT: PATRATU STPP (3X800MW)) PACKAGE : EPC PACKAGE SUPPLIER : BHEL CONT. NO.: CS-9585-001-2	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB- SUPPLIER APPROVAL	ANNEXURE- DOC. No. CS-9585-001-2 Revision No. : 00 DATE: 05/04/2017 PAGE : 1 OF 7

SL.NO.	ITEM	QP/INSPN CAT	QP NO.	PROPOSED SUBVENDORS BY MAIN CONTRACTOR	PLACE	SUB-SUPPLIER APPROVAL STATUS/ CATEGORY	REMARKS
1	LOW PRESSURE PIPING L1 LEVEL VENDOR (REFER NOTE 2)	I		RAUNAQ INTERNATIONAL	FARIDABAD	A	
		I		BRIDGE & ROOF CO	KOLKATA	A	
		I		TECHNOELECTRIC ENGG	KOLKATA	A	
		I		TECHNO FAB ENGG	NEW DELHI	A	
		I		UNITECH MACHINES LTD	GURGAON	A	
		I		THERMOSYSTEMS	HYDERAABAD	A	
		I		IOTL	MUMBAI	A	
		I		BHEL PIPING CENTRE	CHENNAI	A	
		I		GMW	BARODA	DR	
2	AIR CONDITIONING SYSTEM L1 LEVEL VENDOR (REFER NOTE 1& 2)	I		VOLTAS	MUMBAI	A	
		I		STERLING & WILSON	KOLKATA	A	
		I		ADVANCE VENTILATION	DELHI	A	
		I		~~ROOTS COOLING SYSTEM~~	~~NOIDA~~	~~A~~	
		I		GEMINI SHREEWAS (ENGRS) PVT LTD	CHENNAI	DR	
		I		INDUSTRIAL PROJECT & PRODUCTS LTD	BAWAL	DR	
3	VENTILATION SYSTEM L1 LEVEL VENDOR (REFER NOTE 1& 2)	I		VOLTAS	MUMBAI	A	
		I		STERLING & WILSON	KOLKATA	A	
		I		~~ROOTS COOLING SYSTEM~~	NOIDA	~~A~~	
		I		SK SYSTEMS PVT LTD	DELHI	A	
		I		C DOCTOR	KOLKATA	A	
		I		HYDERABAD POLLUTION	HYDERABAD	A	
		I		ADVANCE VENTILATION	DELHI	A	
		I		PACK PLAST ENGG	KOTA	DR	

Bharat Heavy Electricals Limited PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited C & M Deptt. Distt-Ramgarh (Jharkhand)

FORMAT NO.: QS-01-QAI-P-01/F3-R0 ENGG. DIV./QA&I

SL.NO.	ITEM	QP/INSPN CAT	QP NO.	PROPOSED SUBVENDORS BY MAIN CONTRACTOR	PLACE	SUB-SUPPLIER APPROVAL STATUS/ CATEGORY	REMARKS
		I		INDUSTRIAL PROJECT & PRODUCTS LTD	BAWAL	DR	
		I		TAP ENGINEERING	CHENNAI	DR	
4	COMPRESSED AIR SYSTEM L1 LEVEL VENDOR (REFER NOTE 1& 2)	I		ELGI EQUIPMENTS	COIMBATORE	A	
		I		ATLAS COPCO	PUNE	A	
		I		INGERSOLL RAND	AHMEDABAD	A	
5	PLATE HEAT EXCHANGER	I		TRANTER INDIA	PUNE	A	HT PLATES &GASKETS FROM TRANTER, SWEDEN/USA. HT PLATES FROM HIKASA, JAPAN
		I		TRANTER INDIA	PUNE	A	ACCEPTABLE FOR INDIGENOUSLY PRESSED HT PLATE SIZE UPTO 2107 MM LENGTH X 940 MM WIDTH X 0.6MM THICKNESS OF SS316 MATERIAL. GASKET AS PER APPROVAL CONDITION.
		I		KELVION INDIA PVT LTD (FORMLY GEA ECOFLEX INDIA)	PUNE	A	HT PLATES &GASKETS FROM GEA ECOFLEX, GERMANY
		I		KELVION INDIA PVT LTD (FORMLY GEA ECOFLEX INDIA)	PUNE	A	ACCEPTABLE FOR INDIGENOUSLY PRESSED HT PLATE SIZE UPTO 1736 MM LENGTH X 745 MM WIDTH X 0.5MM THICKNESS. GASKETS AS PER APPROVAL CONDITION.
		I		ALPHA LAVAL	SATARA	A	HT PLATES &GASKETS FROM ALPHA LAVAL, SWEDEN

Bharat Heavy Electricals Limited ★ PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited ★ Distt-Ramgarh(Jharkhand) C & M Deptt.

एनटीपीसी NTPC	PROJECT: PATRATU STPP (3X800MW)) PACKAGE : EPC PACKAGE SUPPLIER : BHEL CONT. NO.: CS-9585-001-2	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB- SUPPLIER APPROVAL	ANNEXURE- DOC. No. CS-9585-001-2 Revision No. : 00 DATE: 05/04/2017 PAGE : 3 OF 7

SL.NO.	ITEM	QP/INSPN CAT	QP NO.	PROPOSED SUBVENDORS BY MAIN CONTRACTOR	PLACE	SUB-SUPPLIER APPROVAL STATUS/ CATEGORY	REMARKS
		I		ALPHA LAVAL	SATARA	A	ACCEPTABLE FOR INDIGENOUSLY PRESSED HT PLATES OF SIZE UPTO 2250MM LENGTH X 750MM WIDTH X 0.6MM THICKNESS.
		I		IDMC	ANAND	A	HT PLATES & GASKETS FROM SONDEX, DENMARK
		I		HISAKA	JAPAN	A	
		I		SONDEX INDIA	VADODARA	A	HT PLATES FROM SONDEX, DENMARK
6	HORIZONTAL CENTRIFUGAL PUMP (UP TO 1000 CUM/HR)	I		KIRLOSKAR BROS LTD.	KIRLOSKARWADI	A	
		I		MATHER & PLATT	PUNE	A	
		I		MATHER & PLATT	KOLHAPUR	A	
		I		SAM TURBO	COIMBATORE	A	
		I		FLOWMORE	GHAZIABAD	A	
		I		FLOWMORE	GHAZIABAD	A	
		I		BEST AND CROMPTON	CHENNAI	A	
		I		JYOTI	VADODARA	A	
		I		WPIL	GHAZIABAD	A	
		I		KISHORE PUMPS	PUNE	A	UPTO 500M3/HR
		I		KSB	PUNE	A	
7	FUEL OIL UNLOADING SYSTEM L1 LEVEL VENDOR (REFER NOTE 1 & 2)	I		RAUNAQ INTERNATIONAL LTD	FARIDABAD	A	
		I		GMW	VADODRA	A	
		I		UNITECH MACHINES LTD	GURGAON		
		I		TECHNO ELECTRIC	KOLKATA		

Bharat Heavy Electricals Limited PS-MKTG Delhi

Damodar Valley Vidyut Utpadan Nigam Limited * Distt. Ramgarh (Jharkhand) * Patratu C & M Deptt.

एनटीपीसी NTPC	PROJECT: PATRATU STPP (3X800MW)) PACKAGE : EPC PACKAGE SUPPLIER : BHEL CONT. NO.: CS-9585-001-2	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB- SUPPLIER APPROVAL	ANNEXURE- DOC. No. CS-9585-001-2 Revision No. : 00 DATE: 05/04/2017 PAGE : 4 OF 7

SL.NO.	ITEM	QP/INSPN CAT	QP NO.	PROPOSED SUBVENDORS BY MAIN CONTRACTOR	PLACE	SUB-SUPPLIER APPROVAL STATUS/ CATEGORY	REMARKS
				ENGG			
		I		XICON INTERNATIONAL	THANE	DR	
		I		NEW FIRE ENGINEERS	NEW DELHI	DR	
		I		SHALCOT	NOIDA	A	
		I		THERMOSYSTEMS	HYDERABAD	A	
8	COOLING TOWER- IDCT L1 LEVEL VENDOR (REFER NOTE 1& 2)	I		L&T	CHENNAI	A	
		I		NBCC	NEW DELHI	A	
		I		GEA COOLING TOWER	CHENNAI	A	
		I		HAMMON SHRIRAM	UMBERGAON	A	
		I		PAHARPUR COOLING TOWERS	NEW DELHI	A	
		I		FANS AS	CZECK	A	
		I		PAL TECH COOLING TOWER	GURGAON	A	
9	CW TREATMENT SYSTEM L1 LEVEL VENDOR (REFER NOTE 1 & 2	I		DRIPLEX	NEW DELHI	A	
		I		THERMAX	PUNE	A	
		I		ION EXCHANGE	MUMBAI	A	
		I		TRIVENI ENGG	NOIDA	A	
		I		VASU CHEMICALS	MUMBAI	DR	
		I		CHEMBOND	MUMBAI	DR	
10	CONDENSATE POLISHING PLANT L1 LEVEL VENDOR (REFER NOTE 1 & 2)	I		DRIPLEX	HARIDWAR	A	
		I		ION EXCHANGE	MUMBAI	A	
		I		BGR ENERGY	CHENNAI	A	
		I		THERMAX	PUNE	A	
11	(SUBMERSIBLE TYPE) 50 M3/HR, 20 MWC	I		KISHORE PUMPS	PUNE	A	
		I		KSB	PUNE	A	
		I		KIRLOSKAR BROS LTD.	KIRLOSKARWADI	A	
		I		AQUA MACHINERY	AHMEDABAD	A	
		I		DARLING PUMPS	INDORE	A	

Bharat Heavy Electricals Limited PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited • Distt.-Ramgarh (Jharkhand) • C & M Deptt.

ENGG. DIV. QA&I

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एनटीपीसी NTPC	PROJECT: PATRATU STPP (3X800MW)) PACKAGE : EPC PACKAGE SUPPLIER : BHEL CONT. NO.: CS-9585-001-2	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB- SUPPLIER APPROVAL	ANNEXURE- DOC. No. CS-9585-001-2 Revision No. : 00 DATE: 05/04/2017 PAGE : 5 OF 7

SL.NO.	ITEM	QP/INSPN CAT	QP NO.	PROPOSED SUBVENDORS BY MAIN CONTRACTOR	PLACE	SUB-SUPPLIER APPROVAL STATUS/ CATEGORY	REMARKS
				WPIL	GHAZIABAD	A	
		I		MBH	AHMEDABAD		
13	WATER PRE TREATMENT PLANT & LIQUID EFFLUENT TREATMENT PLANT L1 Level Vendor (Refer Note 1 & 2)	I		DRIPLEX	NEW DELHI	A	
		I		TRIVENI	NOIDA	A	
		I		BRIDGE & ROOF	KOLKATA	A	
		I		GEO MILLER	NEW DELHI	A	
		I		MCNALLY BHARAT	KOLKATA	A	
		I		VA TECH WABAG	PUNE	A	
		I		GANNON DUNKERLEY	NEW DELHI	A	
		I		UEM INDIA	NOIDA	A	
		I		ION EXCHANGE	MUMBAI	A	
		I		PARAMOUNT	VADODARA	DR	
		I		THERMAX	PUNE	DR	
		I		PBI ASSOCIATES	PUNE	DR	
		I		SHRI RAM EPC	CHENNAI	DR	
		I		CLEAR WATER	NEW DELHI	DR	
		I		AQUA DESIGN	CHENNAI	DR	
		I		VEOLIA INDIA PVT LTD	CHENNAI	DR	
14	DM PLANT (CONVENTIONAL ION EXCHANGE BASED) L1 Level Vendor (Refer Note 1 & 2)	I		THERMAX	PUNE	A	
		I		ION EXCHANGE	MUMBAI	A	
		I		DRIPLEX	NEW DELHI	A	
		I		PARAMOUNT	VADODARA	DR	
		I		AQUA DESIGN	CHENNAI	DR	
		I		V A TECH WABAG	PUNE	DR	
		I		AQUA TECH SYSTEMS	PUNE	DR	
		I		DOSHION	AHEMDABAD	DR	

Bharat Heavy Electricals Limited PS-MKTG Delhi

Jatin BHEL, PS

Patratu Vidyut Utpadan Nigam Limited * Distt-Ramgarh (Jharkhand) C & M Deptt.

एनटीपीसी NTPC	PROJECT: PATRATU STPP (3X800MW)) PACKAGE : EPC PACKAGE SUPPLIER : BHEL CONT. NO.: CS-9585-001-2	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB- SUPPLIER APPROVAL	ANNEXURE- DOC. No. CS-9585-001-2 Revision No. : 00 DATE: 05/04/2017 PAGE : 6 OF 7

SL.NO.	ITEM	QP/INSPN CAT	QP NO.	PROPOSED SUBVENDORS BY MAIN CONTRACTOR	PLACE	SUB-SUPPLIER APPROVAL STATUS/ CATEGORY	REMARKS
		I		TRIVENI ENGG	NOIDA	DR	
		I		WIPRO	MUMBAI	DR	
15	DM PLANT (RO+MB PLANT) L1 Level Vendor (Refer Note 1 & 2)	I		TRIVENI	NOIDA	A	
		I		ION EXCHANGE	MUMBAI	A	
		I		DRIPLEX	NEW DELHI	A	
16	SEWAGE TREATMENT PLANT L1 Level Vendor (Refer Note 2)	I		VA TECH WABAG	PUNE	A	
		I		ION EXCHANGE	MUMBAI	A	
		I		TRIVENI	NOIDA	A	
		I		DRIPLEX	NEW DELHI	A	
		I		DECCAN	PUNE	A	
		I		THERMAX	PUNE	A	
		I		GEO MILLER	NEW DELHI	A	
17	CHLORINATION SYSTEM	TO BE PROPOSED AT LATER STAGE				A	

Bharat Heavy Electricals Limited ★ PS-MKTG Delhi

NOTE-1: Subject to Sub-QR clearance by Engg as per Technical Specification

NOTE 2: Comprehensive L-2 list of sub-vendors shall be finalized with the finally selected L-1 vendor but prior to order finalization on L-1 vendor by the Bidder.

★ Patratu Vidyut Utpadan Nigam Limited ★ Distt.-Ramgarh (Jharkhand) C & M Deptt.

एनटीपीसी NTPC	PROJECT: PATRATU STPP (3X800MW)) PACKAGE : EPC PACKAGE SUPPLIER : BHEL CONT. NO.: CS-9585-001-2	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB- SUPPLIER APPROVAL	ANNEXURE- DOC. No. CS-9585-001-2 Revision No. : 00 DATE: 05/04/2017 PAGE : 7 OF 7

SL.NO.	ITEM	QP/INSPN CAT	QP NO.	PROPOSED SUBVENDORS BY MAIN CONTRACTOR	PLACE	SUB-SUPPLIER APPROVAL STATUS/ CATEGORY	REMARKS

1. SYSTEM SUPPLIER / SUB-SUPPLIERSTATUS CATEGORY (SHALL BE FILLED BY NTPC).

A – For those items proposed vendor accepted to NTPC. To be indicated with letter "A" in the list along with condition of approval, if any.

DR - for those items " Details Required " for NTPC review.

Noted: For those items accepted by NTPC without specific sub-vendor approval from NTPC and indicated as "NOTED" in the list.

2. INSPECTION CATEGORY:

CAT I : For those items the quality plans are approved by NTPC and final acceptance will be on physical inspection witness by NTPC.

CAT II : For those items the quality plans are approved by NTPC. However no physical inspection will be done by NTPC. The final acceptance by NTPC shall be on the basis of review of documents as per QP.

CAT III: For those items Main Supplier approves quality plans. The final acceptance by NTPC shall be on the basis of certificate of conformance by Main Supplier.

Engineer (Cat-3) NTPC

Bharat Heavy Electricals Limited ★ PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited ★ Distt-Ramgarh(Jharkhand) C & M Deptt.

Main Contractor

(Jatin Gahlawat)
BHEL, PSM

	PROJECT: PATRATU STPP (3 X 800 MW)		LIST AND STATUS OF ITEM REQUIRING QP AND SUB-SUPPLIER APPROVAL		NTPC DOC NO:	CS-9585-001- 2	
NTPC	PACKAGE: EPC PACKAGE				REV. NO.	0	
	MAIN SUPPLIER: BHEL				DATE	10-Apr-17	
	CONTRACT NO.: CS-9585-001- 2				ANNEXURE		
SR. NO.	ITEM	QAP / INSP. CAT	QAP NO.	PROPOSED SUB SUPPLIER	PLACE OF MANUFACTURING	APPROVAL STATUS	REMARKS
1	Mill Reject Handling System L1 Level Vendor (Refer Note 1 & 2)	I		Macawber Beekay	Delhi	A	
		I		Xiamen Longking	China	A	
		I		Shanghai Sinofin New Energy Investment Company	China	DR	
		I		H V Equipments	Noida	A	
2	TG Hall EOT Cranes (Refer Note 1) & Lifting Beam	I		Mukand	Thane	A/DR	Approved Upto 300 Tons
		I		WMI Konecranes	Pune	A/DR	Approved Upto 300 Tons
		I		Anupam Industries	V U Nagar	A/DR	Approved Upto 300 Tons
		I		Unique Industries Handlers	Nasik	A/DR	Approved Upto 300 Tons
		I		HEC	Ranchi	A/DR	Approved Upto 265 Tons
3	Misc EOT Cranes (Sub-vendors indicated at Sl no 2 are also acceptable)	I		Tuobro Furguson India Pvt. Ltd	Kolkata	A/DR	Approved Upto 25 Tons
		I		FAFCO	Vadodara/Mumbai	A/DR	Vadodara works approved - upto 150 Tons, Mumbai - Upto 200 Tons
		I		Grip Engineers	Hyderabad	A/DR	Approved Upto 50 Tons
		I		Reva Industries	Faridabad	A/DR	Approved Upto 45 Tons
		I		Cranex	Sahibabad	A/DR	Approved Upto 35 Tons
		I		Electromech	Pune	DR	
		I		Rockwell Hoisto	Bahadurgarh	DR	
		I		Techno	Ahmedabad	DR	
		I		Mangla Hoist	Greater Noida	DR	
		I		Brady & Morris	Ahmedabad	DR	
		I		GMW	Vadodara	DR	
		I		Terex	Pune	DR	
		I		Meeka Machinery	Ahmedabad	DR	
		I		Safex	Ahmedabad	DR	
		I		Unicorn	Noida	DR	
		I		Henan Weihua	China	DR	
		I		Alpha Services	Bhiwadi	A/DR	Approved for Double Girder upto 40 Tons, Single Girder upto 15 Tons
		I		Century Crane Engineers	Ballabhgarh	A/DR	Approved Upto 30 Tons
4	Misc Electric Hoists	I		Brady & Morlis	Ahmedabad	A/DR	Approved Upto 10 Tons
		I		Consolidated Hoist	Pune / Satara	A/DR	Approved Upto 35 Tons at Satara & Upto 15 Tons at Pune works
		I		Tuobro Furguson India Pvt. Ltd	Kolkata	A/DR	Approved Upto 5 Tons
		I		Grip Engineers	Faridabad	A/DR	Approved Upto 20 Tons

Bharat Heavy Electricals Limited ★ PS-MKTG Delhi

Nirman Bhawan Utpadan Nigam Limited ★ Distt. Ranchi ★ (Jharkhand) C & M Deptt.

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		I		Techno	Ahmedabad	DR	
		I		Tractel Tirfor India Pvt. Ltd	Palwal	A/DR	Approved Upto 15 Tons
		I		Rockwell Hoisto	Bahadurgarh	DR	
		I		Universal Hoisto Fabrik	Thane	A/DR	Approved Upto 20 Tons
		I		Global Technologies	Hyderabad	DR	
		I		Mangla Hoist	Greater Noida	A/DR	Approved Upto 10 Tons
		I		Safex	Ahmedabad	DR	
		I		Meeka Machinery	Ahmedabad	DR	
		I		Reva Industries	Faridabad	A/DR	Approved Upto 25 Tons
		I		Eddy Cranes	Pune	A/DR	Approved Upto 14 Tons
		I		Alpha Services	Bhiwadi	A/DR	Approved Upto 15 Tons
		I		Century Crane Engineers	Ballabhgarh	A/DR	Approved Upto 25 Tons
		I		Grip Engineers	Hyderabad	A/DR	Approved Upto 40 Tons
5	Chain Pulley Block	I		Techno	Ahmedabad	DR	
		I		Brady & Morris	Ahmedabad	DR	
		II		Century Crane Engineers	Ballabhgarh	A/DR	Approved Upto 15 Tons
		I		Universal Hoisto Fabrik	Thane	DR	
		II		Tractel Tirfor India Pvt. Ltd	Kalyani	A/DR	Approved Upto 20 Tons
		I		Tuobro Furguson India Pvt. Ltd	Kolkata	DR	
6	Fire Tender	I		Wadia Bodybuilders	Ahmedabad	A	
		I		Ambala Coach	Ambala	A	
		I		Brijbasi Hi Tech	Mathura	DR	
		I		Vijay Fire	Umbergaon	A	

Note 1 : Subject to Sub-QR clearance by Engg as per Technical Specification

Note 2 : Comprehensive L-2 list of sub-vendors shall be finalized alongwith the finally selected L-1 vendor but prior to order finalization on L-1 vendor by the Bidder.

LEGENDS

1. SYSTEM SUPPLIER / SUB-SUPPLIER APPROVAL STATUS CATEGORY (SHALL BE FILLED BY NTPC)

A – For these items proposed vendor is acceptable to NTPC. To be indicated with letter "A" in the list alongwith the condition of approval, if any.

DR – For these items "Detailed required" for NTPC review. To be identified with letter "DR" in the list.

NOTED – For these items vendors are approved by Main Supplier and accepted by NTPC without specific vendor approval from NTPC. To be identified with "NOTED."

2. QP/INSPN CATEGORY:

CAT-I : For these items the Quality Plans are approved by NTPC and the final acceptance will be on physical inspection witness by NTPC.

CAT-II : For these items the Quality Plans approved by NTPC. However no physical inspection shall be done by NTPC. The final acceptance by NTPC shall be on the basis review of documents as per approved QP.

CAT-III : For these items Main Supplier approves the Quality Plans. The final acceptance by NTPC shall be on the basis certificate of conformance by the main supplier.

Patratu Vidyut Utpadan Nigam Limited * Distt-Ramgarh (Jharkhand) * C & M Deptt. Page 2 of 2

Bharat Heavy Electricals Limited * PS MKTG Delhi

	PROJECT: PATRATU STPP (3 X 800 MW)		LIST AND STATUS OF ITEM REQUIRING QP AND SUB-SUPPLIER APPROVAL		NTPC DOC NO:	CS-9585-001- 2	
NTPC	PACKAGE: EPC PACKAGE				REV. NO.	0	
	MAIN SUPPLIER: BHEL				DATE	05-Apr-17	
	CONTRACT NO.: CS-9585-001- 2				ANNEXURE		
SR. NO.	ITEM	QAP / INSP. CAT	QAP NO.	PROPOSED SUB SUPPLIER	PLACE OF MANUFACTURING	APPROVAL STATUS	REMARKS
1	Coal Handling Plant L1 Level Vendor (Refer Note 1 & 2) & Limestone/ Gypsum Handling Plant L1 Vendor (Refer Note2)	I		BHEL - ISG	Bangalore	A	
2	Ash Handling System L1 Level Vendor (Refer Note 1 & 2)	I		DCIPS	Kolkata	A	
		I		MBE	Kolkata	A	
		I		Macawber Beekay	Delhi	A	
		I		Mcgale Pneumatic	Nagpur	DR	
		I		UCC	USA / India	DR	
		I		BHEL-ISG	Bangalore	DR	
		I		Indure	Delhi	A	
2a	Dry Bottom Ash Handling System L1 Level Vendor (Refer Note 1 & 2)	I		Magaldi System	Italy	DR	
		I		Clyde Bergman	India	DR	
		I		China DatangTechnological & Engineering Co.	China	DR	
		I		Nari Futong Science and Technology Development Co. Ltd.	China	DR	

Note 1 : Subject to Sub-QR clearance by Engg as per Technical Specification

Note 2 : Comprehensive L-2 list of sub-vendors shall be finalized alongwith the finally selected L-1 vendor but prior to order finalization on L-1 vendor by the Bidder.

LEGENDS

1. SYSTEM SUPPLIER / SUB-SUPPLIER APPROVAL STATUS CATEGORY (SHALL BE FILLED BY NTPC)

A – For these items proposed vendor is acceptable to NTPC. To be indicated with letter "A" in the list alongwith the condition of approval, if any.

DR – For these items "Detailed required" for NTPC review. To be identified with letter "DR" in the list.

2. QP/INSPN CATEGORY:

CAT-I : For these items the Quality Plans are approved by NTPC and the final acceptance will be on physical inspection witness by NTPC.

CAT-II : For these items the Quality Plans approved by NTPC. However no physical inspection shall be done by NTPC. The final acceptance by NTPC shall be on the basis review of documents as per approved QP.

CAT-III : For these items Main Supplier approves the Quality Plans. The final acceptance by NTPC shall be on the basis certificate of conformance by the main supplier.

5th Apr'17 (CINDRAJIT DEY)

5/4/17 (ANSHUL JAIN) BHEL-ISG

Patratu Vidyut Utpadan Nigam Limited * Distt-Ramgarh(Jharkhand) C & M Deptt. Page 1 of 1

Bharat Heavy Electricals Limited PS-MKTG Delhi

	PROJECT: PATRATU STPP (3 X 800 MW)		LIST AND STATUS OF ITEM REQUIRING QP AND SUB-SUPPLIER APPROVAL		NTPC DOC NO:	CS-9585-001- 2	
NTPC	PACKAGE: EPC PACKAGE				REV. NO.	0	
	MAIN SUPPLIER: BHEL				DATE	05-Apr-17	
	CONTRACT NO.: CS-9585-001- 2				ANNEXURE		
SR. NO.	ITEM	QAP / INSP. CAT	QAP NO.	PROPOSED SUB SUPPLIER	PLACE OF MANUFACTURING	APPROVAL STATUS	REMARKS
1	Fire Protection & Detection System L1 Level Vendor (Refer Note 1 & 2)	I		Lloyd Insulations	Delhi	A	
		I		Minimax GmbH	Germany	A	
		I		Tyco Fire & Security	Bangalore	A	
		I		Hitek Engineering	Mumbai	A	
		I		UTC Fire & Security	Gurgaon	A	
		I		Unitech Machines	Gurgaon	A	
		I		Mehta & Associates	Ahmedabad	A	
		I		Sureland	China	A	
		I		Consilium Middle East	UAE	A	
		I		Sterling & Wilson	Kolkata	A	
		I		Mx Systems International	Mumbai	A	
		I		Agince Fire Protection	Chennai	DR	
		I		Thermosystems	Hyderabad	A	
		I		BHEL - Hyderabad	Hyderabad	A	
		I		Technofab	Faridabad	A	
		I		Mather & Platt	Pune	A	

Note 1 : Subject to Sub-QR clearance by Engg as per Technical Specification

Note 2 : Comprehensive L-2 list of sub-vendors shall be finalized alongwith the finally selected L-1 vendor but prior to order finalization on L-1 vendor by the Bidder.

LEGENDS

1. SYSTEM SUPPLIER / SUB-SUPPLIER APPROVAL STATUS CATEGORY (SHALL BE FILLED BY NTPC)

A – For these items proposed vendor is acceptable to NTPC. To be indicated with letter "A" in the list alongwith the condition of approval, if any.

DR – For these items "Detailed required" for NTPC review. To be identified with letter "DR" in the list.

2. QP/INSPN CATEGORY:

CAT-I : For these items the Quality Plans are approved by NTPC and the final acceptance will be on physical inspection witness by NTPC.

CAT-II : For these items the Quality Plans approved by NTPC. However no physical inspection shall be done by NTPC. The final acceptance by NTPC shall be on the basis review of documents as per approved QP.

CAT-III : For these items Main Supplier approves the Quality Plans. The final acceptance by NTPC shall be on the basis certificate of conformance by the main supplier.

Bharat Heavy Electricals Limited * PS-MKTG Delhi *

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Jatin

(Jatin Gahlawat)
(BHEL, PS-MKTG)

एनटीपीसी NTPC	PROJECT :PATRATU STPP (3X800 MW) PACAKGE : EPC Sub Package: Elevators CONTRACTOR : M/S BHEL CONT. NO. CS-9585-001-2	LIST OF ITEMS REQUIRING QP APPROVAL & ACCEPTABLE VENDOR CONTRACTOR : M/S BHEL	REF NO : 9585-001-QOE-R-01 REVISION NO. 00 DATE: 24TH April 2017

Sl. No.	ITEM	QP / INS CAT.	QP No:- 9585-001-QVE-	QP SUB. SCH.	QP APPL SCHE DULE	SUB-SUPPLIERS	PLACE	SUB- SUPPLIER APPL STATUS AS PER NTPC	SC APPL SCHEDULE	REMARKS
1)	ELEVATOR	I				ECE	GHAZIABAD	A		
		I				TECHNO	AHMEDABAD	A		
		I				OTIS	MUMBAI	A		
		I				KONE	CHENNAI	A		
		I				OMEGA	AHMEDABAD	A		
		I				SAMIL ELTEC	KOREA	A		
						JOHNSON	CHENNAI / NAGPUR	DR		
						SCHINDLER	MUMBAI	DR		

Jatin
24/04/17

(JATIN GAHLAWAT)
BHEL

Bharat Heavy Electricals Limited ★ PS-MKTG Delhi

★ Patratu Vidyut Utpadan Nigam Limited ★ Distt-Ramgarh(Jharkhand) C & M Deptt.

NTPC	PROJECT: PATRATU 3X800 MW PACKAGE: TG CONTRACTOR: BHEL HARIDWAR CONTRACT NO.: 9595 001-110	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUBCONTRACTOR APPROVAL SUB SYSTEM: TG & AUX	REF NO. : REV NO.: DATE 05.04.17

Sl No.	Item	QP Insp.Cat.	NTPC QP No. QVE-Q-	Vendor/ Manufacturer Name	Place	SC_APPL_STATUS	Remarks
1	STATOR FRAME FABRICATION	I		BHEL-HEEP	HARDWAR	A	
2	STATOR FRAME MACHINING	I		BHEL-HEEP	HARDWAR	A	
3	SPRING BASKET	I		BHEL-HEEP	HARDWAR	A	
4	CORE BAR	I		BHEL-HEEP	HARDWAR	A	
5	STATOR LAMINATION	I		BHEL-CSU	JAGDISHPUR	A	
6	FLUX TRAP	I		BHEL-HEEP	HARDWAR	A	STAMPINGS FROM CSU JAGDISHPUR
7	RIPPLE SPRING	II		KREMPAL GMBH	GERMANY	A	NO SEP QP
7	RIPPLE SPRING	*		SIEMENS LIMITED	INDIA	DR	
8	TENSION BOLT FOR STATOR CORE (INSULATED)	II		BHEL-HEEP	HARIDWAR	A	
9	STATOR CORE ASSLY	I		BHEL-HEEP	HARDWAR	A	
10	FLAT SPRINGS AND BASKET ASEMBLY	I		BHEL-HEEP	HARDWAR	A	
11	BUS BAR CONNECTION TUBES	II		LUVATA PORI	FINLAND	A	NO SEPARATE QP
11	BUS BAR CONNECTION TUBES	II		BUNT METAL	AUSTRIA	A	
11	BUS BAR CONNECTION TUBES	II		KME GERMANY GMBH & CO. KG	GERMANY	A	
11	BUS BAR CONNECTION TUBES	*		HAEGANG ALLOY CO. LTD.	KOREA	DR	
12	SOLID COPPER CONDUCTOR (FOR STATOR BAR)	I		PEARL INSULATIONS	BANGLORE	A	
12	SOLID COPPER CONDUCTOR (FOR STATOR BAR)	I		MAHENDRA INDUSTRIES	BANGLORE	A	

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05.04.17
CSK Chauhan

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NTPC	PROJECT: PATRATU 3X800 MW PACKAGE: TG CONTRACTOR: BHEL HARIDWAR CONTRACT NO.: 9595 001-110	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUBCONTRACTOR APPROVAL SUB SYSTEM: TG & AUX	REF NO. : REV NO.: DATE 05.04.17

Sl No.	Item	QP Insp.Cat.	NTPC QP No. QVE-Q-	Vendor/ Manufacturer Name	Place	SC_APPL_STATUS	Remarks
12	SOLID COPPER CONDUCTOR (FOR STATOR BAR)	II		VONROLL	SWITZERLAND	A	NO SEP QP
12	SOLID COPPER CONDUCTOR (FOR STATOR BAR)	II		GEBAUER & GRILLER	AUSTRIA	A	NO SEP QP
13	HOLLOW SS CONDUCTOR (STATOR BAR)	II		FINE TUBES LTD.	ENGLAND	A	NO SEP QP
13	HOLLOW SS CONDUCTOR (STATOR BAR)	II		SIEMENS AG	GERMANY	DR	
14	MICA SPLITTING INSULATING TAPE	II		ISOVOLTA (I) PVT. LTD.,	NASIK	A	NO SEP QP
14	MICA SPLITTING INSULATING TAPE	*		LAKSHMANAN ISOLA PVT LTD	BANGLORE	DR	
15	OVER HANG SUPPORT RING	II		ROECHLING ENGINEERING PLASTICS	GERMANY	A	NO SEP QP
15	OVER HANG SUPPORT RING	II		POWER & COMPOSITE TECHNOLOGIES	USA	A	NO SEP QP
15	OVER HANG SUPPORT RING	*		KOMPOZYTY SP.Z.O.O	POLAND	DR	
15	OVER HANG SUPPORT RING	*		NANTONG DAWNTINE ELECTRICAL	CHINA	DR	
16	STATOR SLOT WEDGE (RAW MATERIAL)	II		PERMALI WALLACE PRIVATE	BHOPAL	A	NO SEP QP
16	STATOR SLOT WEDGE (RAW MATERIAL)	II		MICAPLY	BHOPAL	A	NO SEP QP
16	STATOR SLOT WEDGE (RAW MATERIAL)			LAMTUF PLASTICS LTD	HYDERABAD	DR	
16	STATOR SLOT WEDGE (RAW MATERIAL)			THE BOMBAY BURMAH TRADING CORP	RUDRAPUR	DR	
17	WATER SUPPLY HOSE (INSULATED)	II		DR SCHNABEL GMBH & CO KG LIMBURG	GERMANY	A	NO SEP QP

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NTPC	PROJECT: PATRATU 3X800 MW PACKAGE: TG CONTRACTOR: BHEL HARIDWAR CONTRACT NO.: 9595 001-110	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUBCONTRACTOR APPROVAL SUB SYSTEM: TG & AUX	REF NO. : REV NO.: DATE 05.04.17

Sl No.	Item	QP Insp.Cat.	NTPC QP No. QVE-Q-	Vendor/ Manufacturer Name	Place	SC_APPL_STATUS	Remarks
17	WATER SUPPLY HOSE (INSULATED)	II		CRANE RESISTOFLEX	USA	A	NO SEP QP
17	WATER SUPPLY HOSE (INSULATED)	I		MIL INDUSTRIES LIMITED	CHENNAI	A	
18	FIELD LEAD CORE BAR	II		KME	GERMANY	DR	NO SEP QP
19	CONTACT BOLT (RAW MATERIAL)	II		SOCIETA METALLURGICA	ITALY	A	NO SEP QP
19	CONTACT BOLT (RAW MATERIAL)	II		BUNT METAL	AUSTRIA	A	NO SEP QP
19	CONTACT BOLT (RAW MATERIAL)	*		KME	GERMANY	DR	
20	HEADER FOR STATOR (ASSEMBLY)	I		BHEL-HEEP	HARDWAR	A	
21	ETS MATERIAL	II		THYSSEN KRUPP ELECTRICAL STEEL	NASIK	A	NO SEP QP
21	ETS MATERIAL	II		ARCELOR MITTAL INTERNATIONAL	LUXAMBOURG	A	NO SEP QP
21	ETS MATERIAL	II		THYSSENKRUPP MATERIAL TRADING	GERMANY	A	NO SEP QP
21	ETS MATERIAL	II		VOESTALPINE	AUSTRIA	DR	
21	ETS MATERIAL	II		ALLOVERZE	GERMANY	A	NO SEP QP
22	BAFFLE RING & BAFFLE RING CARRIER MACHINING	I		BHEL-HEEP	HARDWAR	A	
23	CORE PRESS RING	II		BHEL-HEEP	HARDWAR	A	NO SEP QP
24	HEADER TUBES	II		BHEL APPROVED SOURCE		A	NO SEP QP
25A	SS WATER BOX FOR STATOR BARS (TOP PART)	*		INVESTMENT & PRECISION	BHAVNAGAR (GUJARAT)	DR	
25A	SS WATER BOX FOR STATOR BARS (TOP PART)	II		ZOLLERN GMBH & CO	GERMANY	DR	NO SEP QP
25A	SS WATER BOX FOR STATOR BARS (TOP PART)	II		SIEMENS AG	GERMANY	A	NO SEP QP
25A	SS WATER BOX FOR STATOR BARS (TOP PART)	I		PTC	NORTH GUJRAT	DR	

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NTPC	PROJECT: PATRATU 3X800 MW PACKAGE: TG CONTRACTOR: BHEL HARIDWAR CONTRACT NO.: 9595 001-110	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUBCONTRACTOR APPROVAL SUB SYSTEM: TG & AUX	REF NO. : REV NO.: DATE 05.04.17

Sl No.	Item	QP Insp.Cat.	NTPC QP No. QVE-Q-	Vendor/ Manufacturer Name	Place	SC_APPL_STATUS	Remarks
25B	SS WATER BOX FOR STATOR BARS (BOTTOM PART)	II		WERNER GIETZNAUER	GERMANY	A	NO SEP QP
25B	SS WATER BOX FOR STATOR BARS (BOTTOM PART)	*		SIEMENS LIMITED	INDIA	DR	
25B	SS WATER BOX FOR STATOR BARS (BOTTOM PART)	II		SIEMENS AG	GERMANY	A	NO SEP QP
26	STATOR WINDING BAR	I		BHEL-HEEP	HARDWAR	A	
27	STATOR WINDING ASSEMBLY	I		BHEL-HEEP	HARDWAR	A	
28	GENERATOR SHAFT FORGING	II		BUDERUS EDELSTAHL	GERMANY	A	
28	GENERATOR SHAFT FORGING	II		JSW	JAPAN	A	
28	GENERATOR SHAFT FORGING	II		SAARSCHMIEDE	GERMANY	A	
28	GENERATOR SHAFT FORGING	II		JCFC	JAPAN	A	
28	GENERATOR SHAFT FORGING	II		CHINA FIRST HEAVY INDUSTRIES	CHINA	A	
28	GENERATOR SHAFT FORGING	*		CHINA NATIONAL ERZHONG GROUP	CHINA	DR	
28	GENERATOR SHAFT FORGING	*		UMP TRADING (Manufacturer: JSC ENERGOMASHPETSTAL UKRAINE)	SWITZERLAND	DR	
28	GENERATOR SHAFT FORGING	*		SHAANXI SENWELL	CHINA	DR	
28	GENERATOR SHAFT FORGING	*		SHEFFIELD FORGEMASTERS	UK	DR	
28	GENERATOR SHAFT FORGING	II		SDF-TURNI	ITALY	A	
28	GENERATOR SHAFT FORGING	*		S C DOOSAN	KOREA	DR	
29	GENERATOR SHAFT MACHINING	I		BHEL-HEEP	HARDWAR	A	
30	CURRENT CARRYING BOLTS FOR ROTOR	I		BHEL HEEP	HARDWAR	A	

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Patratu Vidyut Utpadan Nigam Limited ★ Distt-Ramgarh(Jharkhand) ★ C & M Deptt.

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NTPC	PROJECT: PATRATU 3X800 MW PACKAGE: TG CONTRACTOR: BHEL HARIDWAR CONTRACT NO.: 9595 001-110	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUBCONTRACTOR APPROVAL SUB SYSTEM: TG & AUX	REF NO. : REV NO.: DATE 05.04.17

Sl No.	Item	QP Insp.Cat.	NTPC QP No. QVE-Q-	Vendor/ Manufacturer Name	Place	SC_APPL_STATUS	Remarks
31	ROTOR COIL FORMING	I		BHEL HEEP	HARDWAR	A	
32	ROTOR SLOT ANGLE	I		SAHNEY KIRKWOOD PVT. LTD.	NEW DELHI	A	
32	ROTOR SLOT ANGLE	II		ABB SWITZERLAND LTD.	SWITZERLAND	A	NO SEP QP
32	ROTOR SLOT ANGLE	II		VON ROLL ISOLA	FRANCE	A	NO SEP QP
32	ROTOR SLOT ANGLE	II		POWER & COMPOSITE TECHNOLOGIES	USA	DR	
33	FIELD LEAD CORE BAR MACHINING	I		BHEL-HEEP	HARDWAR	A	
34	RETAINING RING MACHINING	I		BHEL-HEEP	HARDWAR	A	
35	RETAINING RING	II		SAARSCHMIEDE	GERMANY	A	NO SEP QP
35	RETAINING RING	II		ENERGIETECHNIK	GERMANY	A	NO SEP QP
35	RETAINING RING	II		JSW	JAPAN	A	NO SEP QP
35	RETAINING RING	*		AUBERT & DUVAL	FRANCE	DR	
35	RETAINING RING	*		DEYANG WANXIN	CHINA	DR	
36	FAN BLADE FOR COMPRESSOR M/C	I		BHEL-HEEP	HARDWAR	A	
37	FAN BLADE FOR COMPRESSOR (RAW MATERIAL) HW10786 –X20Cr 13	I					Refer ST List for same grade material for blade bars
38	ROTOR WINDING ASSLY.(GEN.)	I		BHEL HEEP	HARDWAR	A	
39	GENERATOR ROTOR -FINAL	I		BHEL-HEEP	HARDWAR	A	
40	BEARING SHELL FORGING (GENERATOR)	I		BHEL-CFFP	HARDWAR	A	
41	BEARING COMPLETE (EXCITER)	*		SIEMENS LIMITED	INDIA	DR	
41	BEARING COMPLETE (EXCITER)	II		RENK AG	GERMANY	A	
41	BEARING COMPLETE (EXCITER)	II		ZOLLERN	BRAZIL	A	
41	BEARING COMPLETE (EXCITER)	II		EURO BEARINGS	ITALY	A	

Bharat Heavy Electricals Limited PS-MKTG Delhi

R. Sharma

05.04.17

NTPC	PROJECT: PATRATU 3X800 MW PACKAGE: TG CONTRACTOR: BHEL HARIDWAR CONTRACT NO.: 9595 001-110	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUBCONTRACTOR APPROVAL SUB SYSTEM: TG & AUX	REF NO. : REV NO.: DATE 05.04.17

Sl No.	Item	QP Insp.Cat.	NTPC QP No. QVE-Q-	Vendor/ Manufacturer Name	Place	SC_APPL_STATUS	Remarks
42	HIGH PRESSURE HOSES FOR BEARING PEDESTAL	*		ORIENTAL ENGINEERING WORKS	YAMUNANAGAR	DR	
42	HIGH PRESSURE HOSES FOR BEARING PEDESTAL	II		PARKER HANNIFINE	GERMANY	A	THROUGH PARKER HANNIFINE INDIA. NO SEP QP
42	HIGH PRESSURE HOSES FOR BEARING PEDESTAL	*		HYDRAULIC TECHNIK	GERMANY	DR	THROUGH SMT , HARIDWAR
43	END SHIELD FABRICATION &MACHINING	I		BHEL-HEEP	HARDWAR	A	
44	SHAFT SEAL ASSEMBLY	I		BHEL-HEEP	HARDWAR	A	
45	BEARING ASSEMBLY	I		BHEL-HEEP	HARDWAR	A	
46	COMPRESSOR HUB M/C & ASSEMBLY	I		BHEL-HEEP	HARDWAR	A	
47	HYDROGEN COOLER	I		BHEL-HEEP	HARIDWAR	A	
47	HYDROGEN COOLER	*		LORD VISHWAKARMA HEAT EXCHANGER	KANKHAL (HARIDWAR)	DR	
47	HYDROGEN COOLER	*		LAXMI ENGINEERING INDUSTRIES	BHOPAL	DR	
47	HYDROGEN COOLER	*		FITWELL CORPORATION	BHOPAL	DR	
48	DC LEAD ASSLY	I		BHEL-HEEP	HARDWAR	A	
49	TUBES FOR COOLERS (BRASS / COPPER TUBES)	II		MULTIMETALS	KOTA	A	NO SEP QP
49	TUBES FOR COOLERS (BRASS/ COPPER TUBES)	II		METAL ALLOYS	JAMNAGAR	A	NO SEP QP
49	TUBES FOR COOLERS (BRASS/ COPPER TUBES)	*		MEHTA TUBES	VAPI	DR	
49	TUBES FOR COOLERS (BRASS/ COPPER TUBES)	*		ITM	MUMBAI	DR	

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Patratu Vidyut Utpadan Nigam Ltd. * Distt-Ramgarh (Jharkhand) * C & M Deptt.

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NTPC	PROJECT: PATRATU 3X800 MW PACKAGE: TG CONTRACTOR: BHEL HARIDWAR CONTRACT NO.: 9595 001-110	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUBCONTRACTOR APPROVAL SUB SYSTEM: TG & AUX	REF NO. : REV NO.: DATE 05.04.17

Sl No.	Item	QP Insp.Cat.	NTPC QP No. QVE-Q-	Vendor/ Manufacturer Name	Place	SC_APPL_STATUS	Remarks
50	FINNING OF COOLER TUBES	I		LAXMI ENGINEERING INDUSTRIES	BHOPAL	A	
50	FINNING OF COOLER TUBES	I		LORD VISHWAKARMA HEAT EXCHANGE	HARDWAR	A	
50	FINNING OF COOLER TUBES	I		FITWELL CORPORATION	BHOPAL	A	
51	TERMINAL BOX FABRICATION AND MACHING	I		BHEL-HEEP	HARDWAR	A	
52	CONFORMABLE ROPE	II		BIW	GERMANY	A	NO SEP QP
52	CONFORMABLE ROPE	II		TEXPLAS	HARDWAR	A	NO SEP QP
52	CONFORMABLE ROPE	II		SUMICA	HARDWAR	A	NO SEP QP
53	INSULATING BOLTS (RAW MATERIAL)	II		BHEL APPROVED SOURCES		A	NO SEP QP
54	PW FITER, FINE FILTER, OIL FILTER	II		HYDAC (INDIA) PVT. LTD.	INDIA	DR	
54	PW FITER, FINE FILTER, OIL FILTER	II		BOLL & KIRCH FILTERBAU GMBH	GERMANY	A	NO SEP QP
54	PW FITER, FINE FILTER, OIL FILTER	II		L&Z VERFAHRENSTECHNIK GMBH	GERMANY	DR	NO SEP QP
54	PW FITER, FINE FILTER, OIL FILTER	*		SIEMENS LIMITED	INDIA	DR	
55	P W TANK INCLUDING PW PIPING	I		BHEL-HEEP	HARDWAR	A	
56	VAPOUR EXHAUSTER	II		CB DOCTOR	AHEMDABAD	A	
56	VAPOUR EXHAUSTER	II		S.K SYSTEM	DELHI	A	
56	VAPOUR EXHAUSTER	II		AIR LINK	MATHURA	A	
56	VAPOUR EXHAUSTER	II		DUSTECH	FARIDABAD	A	
57	ION EXCHANGER	I		THERMAX LTD.	PUNE	A	
57	ION EXCHANGER	*		SIEMENS LIMITED	INDIA	DR	

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Patratu Vidyut Utpadan Nigam Limited, Distt-Ramgarh (Jharkhand) C & M Deptt.

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Sl No.	Item	QP Insp.Cat.	NTPC QP No. QVE-Q-	Vendor/ Manufacturer Name	Place	SC_APPL_STATUS	Remarks
57	ION EXCHANGER	*		CHEM PROCESS	AHMEDABAD	DR	
57	ION EXCHANGER	*		H K ENTERPRISES	AHMEDABAD	DR	
58	PW PUMP & FILTER UNIT PIPING	I		BHEL-HEEP	HARDWAR	A	
59	PW COOLER FOR STATOR	I		BHEL-HEEP	HARDWAR	A	
59	PW COOLER FOR STATOR	I		ALFA LAVAL (INDIA) LIMITED	PUNE	A	
59	PW COOLER FOR STATOR	I		I.D.M.C. LTD	GUJRAT	DR	
59	PW COOLER FOR STATOR	I		TRANTER INDIA PVT. LIMITED	PUNE	A	
59	PW COOLER FOR STATOR	I		KELVION INDIA (GEA)	PUNE	A	
59	PW COOLER FOR STATOR	*		HRS PROCESS SYSTEMS LIMITED	PUNE	DR	
60	TERMINAL BUSHING	*		SIEMENS LIMITED	INDIA	DR	
60	TERMINAL BUSHING	II		TRENCH FRANCE SAS	FRANCE	A	NO SEP QP
60	TERMINAL BUSHING	II		HSP HOCHSPANNUNGSGERAETE GMBH	GERMANY	A	NO SEP QP
60	TERMINAL BUSHING	*		SUZHOU JIU & ZHENG ELECTRIC CO	CHINA	DR	
62	HYDROGEN DRIER (REFRIGERANT TYPE)	I		JINDAL ELECTRONICS	ROORKEE	A	
62	HYDROGEN DRIER (REFRIGERANT TYPE)	I		MELLCON ENGS PVT	NEW DELHI	A	
62	HYDROGEN DRIER (REFRIGERANT TYPE)	I		SPAN	ROORKEE	A	
63	SEAL OIL COOLER	I		ALFA LAVAL (INDIA) LIMITED	PUNE	A	
63	SEAL OIL COOLER	I		BHEL-HEEP	HARDWAR	A	
63	SEAL OIL COOLER	I		TRANTER INDIA PVT. LIMITED	PUNE	A	
63	SEAL OIL COOLER	I		KELVION INDIA (GEA)	PUNE	A	
63	SEAL OIL COOLER	*		I.D.M.C. LTD	GUJRAT	DR	

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NTPC	PROJECT: PATRATU 3X800 MW PACKAGE: TG CONTRACTOR: BHEL HARIDWAR CONTRACT NO.: 9595 001-110	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUBCONTRACTOR APPROVAL SUB SYSTEM: TG & AUX	REF NO. : REV NO.: DATE 05.04.17

Sl No.	Item	QP Insp.Cat.	NTPC QP No. QVE-Q-	Vendor/ Manufacturer Name	Place	SC_APPL_STATUS	Remarks
63	SEAL OIL COOLER	*		HRS PROCESS SYSTEMS LIMITED	PUNE	DR	
64	SEAL OIL PUMP	I		TUSHACO PUMPS	DAMAN	A	
64	SEAL OIL PUMP	I		UT PUMPS	FARIDABAD	DR	
64	SEAL OIL PUMP	*		ALEKTON	CHENNAI	DR	
64	SEAL OIL PUMP	*		HUANGSHAN	CHINA	DR	
64	PRIMARY WATER PUMP	I		KSB INDIA	PUNE	A	
64	PRIMARY WATER PUMP	I		SULZER INDIA	NAVI MUMBAI	A	
64	PRIMARY WATER PUMP	*		WPIL LTD.	GHAZIABAD	DR	
65	H2/CO2/N2/ CYLINDER	II		BPCL	ALLAHABAD	A	
65	H2/CO2/N2/ CYLINDER	II		EVEREST KANTO	BOMBAY	A	
65	H2/CO2/N2/ CYLINDER	II		SARJU IMPEX LTD	GUJRAT	A	
65	H2/CO2/N2/ CYLINDER	*		RAMA CYLINDER	GUJRAT	DR	
66	SEAL OIL UNIT & PIPING	I		BHEL-HEEP	HARDWAR	A	
66	SEAL OIL STORAGE TANK	I		BHEL-HEEP	HARDWAR	A	
67	GAS UNIT & PIPING	I		BHEL-HEEP	HARDWAR	A	
68	CO2 VAPOURISER	I		BHEL-HEEP	HARDWAR	A	
69	GENERATOR ASSEMBLY AT WORKS INCLUDING TERMINAL BUSHING	I		BHEL-HEEP	HARDWAR	A	
70	SILVER BEARING COPPER HOLLOW STRIPS (ROTOR COIL)	II		BUNT METAL	AUSTRIA	A	NO SEP QP
70	SILVER BEARING COPPER HOLLOW STRIPS (ROTOR COIL)	II		BOASHIDA SWISS METAL	SWITZERLAND	A	NO SEP QP
71	MULTI CONTACT BAND	III		MULTI CONTACT BAND	GERMANY	A	NO SEPARATE QP
72	WEDGES FOR ROTOR (DAMPER +SLOT)	II		KM EUROPA	GERMANY	A	NO SEP QP
72	WEDGES FOR ROTOR (DAMPER +SLOT)	II		BOASHIDA SWISS METAL	SWITZERLAND	A	NO SEP QP

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C & M Deptt.

05.04.17

NTPC	PROJECT: PATRATU 3X800 MW PACKAGE: TG CONTRACTOR: BHEL HARIDWAR CONTRACT NO.: 9595 001-110	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUBCONTRACTOR APPROVAL SUB SYSTEM: TG & AUX	REF NO. : REV NO.: DATE 05.04.17

Sl No.	Item	QP Insp.Cat.	NTPC QP No. QVE-Q-	Vendor/ Manufacturer Name	Place	SC_APPL_STATUS	Remarks
72	WEDGES FOR ROTOR (DAMPER +SLOT)	*		ORIENTAL COPPER	THAILAND	DR	For Damper Wedge Only
72	WEDGES FOR ROTOR (DAMPER +SLOT)	II		LUVATA (OUTO KUMPU PORI)	FINLAND	A	NO SEP QP
72	WEDGES FOR ROTOR (DAMPER +SLOT)	II		BUNT METAL	AUSTRIA	A	NO SEP QP
73	LT MOTORS	II		REFER TO BHEL PEM LIST		A	
74	GENERAOR WORKS RUN TEST	I		BHEL HEEP	HARDWAR	A	
75	RUBBER ITEM	III		BHEL APPROVED SOURCES		A	
76	EXCITER SHAFT MACHINING	I		BHEL-HEEP	HARDWAR	A	
77	EXCITER STATOR MAIN	I		BHEL-HEEP	HARDWAR	A	
78	EXCITER STATOR PILOT	I		BHEL-HEEP	HARDWAR	A	
79	EXCITER ROTOR BALANCING	I		BHEL-HEEP	HARDWAR	A	
80	RECTIFIER WHEEL MACHING & ASSLY	I		BHEL-HEEP	HARDWAR	A	
81	DC LEAD ASSLY FOR EXCITER	I		BHEL-HEEP	HARDWAR	A	
82	EXCITER ASSLY (MAIN & PILOT)	I		BHEL-HEEP	HARDWAR	A	
83	EXCITER AIR COOLER	I		BHEL-HEEP	HARIDWAR	A	
83	EXCITER AIR COOLER	I		LORD VISHWAKARMA HEAT EXCHANGER	KANKHAL (HARIDWAR)	DR	
83	EXCITER AIR COOLER	I		LAXMI ENGINEERING INDUSTRIES	BHOPAL	DR	
83	EXCITER AIR COOLER	I		FITWELL CORPORATION	BHOPAL	DR	
84	EXCITER TEST RUN	I		BHEL-HEEP	HARDWAR	A	
85	FORGING FOR MAGNETIC HUB, CENTERING RING, INTERMEDIATE RING, CARRIER HUB, COMPRESSOR HUB,DIODE WHEEL	II		BHEL-CFFP	HARDWAR	A	

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Patratu Vidyut Utpadan Nigam Limited C & M Dept. 05.04.17 Distt. Ramgarh (Jharkhand)

NTPC	PROJECT: PATRATU 3X800 MW PACKAGE: TG CONTRACTOR: BHEL HARIDWAR CONTRACT NO.: 9595 001-110	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUBCONTRACTOR APPROVAL SUB SYSTEM: TG & AUX	REF NO. : REV NO.: DATE 05.04.17

Sl No.	Item	QP Insp.Cat.	NTPC QP No. QVE-Q-	Vendor/ Manufacturer Name	Place	SC_APPL_STATUS	Remarks
86	Machining of MAGNETIC HUB, CENTERING RING, INTERMEDIATE RING, CARRIER HUB, DIODE WHEEL	II		BHEL-HEEP	HARDWAR	A	
87	MAGNET (MATERIAL ONLY)	II		THYSEEN KRUPP MAGNETTECHNIC	GERMANY	A	NO SEP QP
87	MAGNET (MATERIAL ONLY)	II		HANGZHOU PERMANENT MAGNET GROU	CHINA	A	NO SEP QP
87	MAGNET (MATERIAL ONLY)	*		SIEMENS LIMITED	INDIA	DR	
87	PERMANENT MAGNET & SHOE ASSLY FOR EXCITER	I		BHEL-HEEP	HARDWAR	A	
88	MAIN EXCITER ARMATURE WINDING	I		BHEL-HEEP	HARDWAR	A	
89	BALANCING RING	II		SCHMOLZ+BICKENBECH	GERMANY	A	NO SEP QP
89	BALANCING RING	II		RV ENGG	BALLABHGARH	A	NO SEP QP
90	BED PLATE FABRICATION	II		BHEL APPROVED SOURCE		A	
91	EXCITER CORE PRESS RING	*		SOUTHERN ALLOY FOUNDERIES PVT LTD	CHENNAI	DR	
91	EXCITER CORE PRESS RING	*		RATAN ENGINEERING	NEW DELHI	DR	
91	EXCITER CORE PRESS RING	II		SCHMOLZ+ BICKENBECH	GERMANY	A	NO SEP QP
91	EXCITER CORE PRESS RING	II		RV ENGG	BALLABHGARH	A	NO SEP QP
92	EXCITER FRAME (MAIN & PILOT)	I		BHEL-HEEP	HARDWAR	A	
93	RC BLOCK	I		ZENTRONICS SYSTEMS	HYDERABAD		
93	RC BLOCK	I		SIEMENS LIMITED	INDIA	DR	
94	EXCITER SHAFT FORGING	II		ALL SUPPLIERIS OF GENERATOR SHAFT FORGING		A	NO SEP QP
94	EXCITER SHAFT FORGING	I		BHEL CFFP	HARIDWAR	A	
94	EXCITER SHAFT FORGING	I		BHARAT FORGE	PUNE	A	

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Uttar Pradesh Rajya Vidyut Utpadan Nigam Limited Thermal Power Station Dist.-Ramgarh(Bharkhar) C & M Dept.

R. Sharma 05.04.17

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NTPC	PROJECT: PATRATU 3X800 MW PACKAGE: TG CONTRACTOR: BHEL HARIDWAR CONTRACT NO.: 9595 001-110	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUBCONTRACTOR APPROVAL SUB SYSTEM: TG & AUX	REF NO. : REV NO.: DATE 05.04.17

Sl No.	Item	QP Insp.Cat.	NTPC QP No. QVE-Q-	Vendor/ Manufacturer Name	Place	SC_APPL_STATUS	Remarks
94	EXCITER SHAFT FORGING	*		MACKEIL ISPAT	KOLKATA	DR	
94	EXCITER SHAFT FORGING	*		OFAR S.P.A	ITALY	DR	

NOTE 1: IN ADDITION TO ABOVE SOURCES BHEL MAY PROCURE ITEMS FROM SIEMENS, SIEMENS APPROVED SOURCES . BHEL TO SUBMIT DOCUMENTS IN SUPPORT OF SIEMENS APPROVED SOURCE.

NOTE 2: LT MOTORS UPTO 30 KW SHALL BE ACCEPTED BASED ON COC OF MANUFACTURER TC AND CONTRACTOR CONFIRMING AS FOLLOWS: IT IS HEREBY CONFIRMED THAT ABOVE MENTIONED MOTOR/ MOTORS WAS/ WERE MANUFACTURED TAKING CARE OF NTPC SPECIFIC REQUIREMENTS REGARDING ABMIENT TEMP, VOLTAGE FREQUENCY VARIATION , HOT STARTS, PULL OUT TORQUES, STARTING KVA/ KW, TEMP RISE, DISTANCE BETWEEN CENTREOF STUD GLAND PLATE, SPACE HEATER AND TESTED IN ACCORDANCE WITH APPROVED DRAWING/ DATA SHEETS AND LT MOTORS ABOVE 30 KW ACCEPTANCE SHALL BE BASED ON NTPC REVIEW OF ROUTINE TEST INSPECTION REPORT AS PER IS 325 BY MAIN MOTOR/ MOTORS WAS/WERE MANUFACTURED TAKING CARE OF NTPC SPECIFIC REQUIREMENTS REGARDING AMBIENT TEMP, OLTAGE FREQUENCY AND TESTED IN ACCORDANCE WITH APPROVED DRAWINGS/ DATA SHEETS AND LT MOTORS. FOR > 50KW, SEPARATE QP TO BE SUBMITTED

NOTE 3: QP/ INSPECTION CAT-I QP APPROVAL AND INSPECTION BY NTPC: QP/ INSPECTION CAT-II QP APPROVAL BY NTPC, NO PHYSICAL INSPECTION BY NTPC. ACCEPTANCE BASED ON REVIEW OF CONTRACTOR INSPECTION REPORT/ TC. : QP/INSPECTION CAT-III NO QP APL AND INSPECTION BY NTPC, ACCEPTANCE BASED ON REVIEW OF COC BY BHEL.

NOTE 4: A* MEANS SUPPLY EXPERIENCE OF COMPARABLE UNIT TO BE FURNISHED TO NTPC

NOTE 5: * - Inspection category will be decided during vendor evaluation.

** LOCATION TO BE INFORMED LATER

05.04.17

Patratu Vidyut Utpadan Nigam Limited * Distt-Ramgarh(Jharkhand) * C & M Deptt.

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एनटीपीसी NTPC

PROJECT: Patratu Stage I
Package: STEAM TURBINE GENERATOR
CONTRACTOR: SIEMENS AG
CONT_NO:

LIST OF ITEMS REQUIRING QUALITY PLAN AND SUBCONTRACTOR APPROVAL

SUB SYST GENERATOR AND AUX

Ref No: IN1141 000
Revision No: 00
Date: ~~12.10.2016~~ 04.04.17

SR. NO	ITEM	QP /INS--PN CAT.	QP NO. 3530-110	QP SUB-MISSION SCHEDU-LE	QP APPL SCHED ULE	PROPOSED SUB SUPPLIER	PLACE	SS APPL STATUS / CAT	SS DETAIL SUB-SCHED ULE	SS APPL SCHED ULE	APPROVAL STATUS
1	STATOR FRAME FABRICATION	II				ANDRITZ KFT	UNGARN				A
		II				TURBOCARE	POLAND				A
		II				ENERGY EN	SOUTH KOREA				A*
2	STATOR FRAME MACHINING	I				ANDRITZ KFT	UNGARN				A
		I				TURBO CARE	POLAND				A
3	SPRINGS SPRING BASKET ASSLY	II				GEILTZENAUR	DUISBURG/ GERMANY				A
		II				TURBO CARE	POLAND				A
4	CORE BEAM DOVETAIL FOR STATOR	II				GEILTZENAUR	DUISBURG/ GERMANY				A
5	STATOR LAMINATION	I				SIEMENS AG	ERFURT				A
6	FLUX CAP	II					TBD				A
7	TENSION BOLT FOR STATOR CORE(INSULATED)	II				SIEMENS AG	ERFURT				A
8	STATOR CORE	I				SIEMENS AG	MUELHEIM				A
9	STATOR BARS	I				SIEMENS AG	ERFURT GERMANY				A
10	HEADER TUBES (ASSY)	II				DR SCHNABEL	PFORZHEI M/GERMAN Y				A
11	HEADER FOR STATOR	II					TBD				A

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SIEMENS AG Signature
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(BHEL/HARIDWAR)

Siemens Power & Gas

Patratu Vidyut Utpadan Nigam Limited ★ C & M Deptt. ★ Distt-Ramgarh(Jharkhand)

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Revision: 00; Date: 20.10.2016
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एनटीपीसी NTPC	PROJECT: Patratu Stage I Package: STEAM TURBINE GENERATOR CONTRACTOR: SIEMENS AG CONT_NO:	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUBCONTRACTOR APPROVAL SUB SYST GENERATOR AND AUX	Ref No: IN1141 000 Revision No: 00 Date: 12-10-2016

SR NO	ITEM	QP /INS-PN CAT *	QP NO. 3530-110	QP SUB-MISSION SCHEDULE	QP APPL SCHEDULE	PROPOSED SUB SUPPLIER	PLACE	SS APPL STATUS / CAT	SS DETAIL SUB-SCHEDULE	SS APPL SCHEDULE	APPROVAL STATUS
12	OVER HANG SUPPORT RING	II				ROCHLING	HAREN				A
13	RIPPLE SPRING	II				KREMPEL	WEHINGEN/GERMANY				A
14	STATOR WINDING ASSEMBLY INCL RIPPLE SPRING & O/H SUPPORTS	I				SIEMENS AG	MUELHEIM				A
15	GENERATOR SHAFT FORGING	II				SDF TURNI	ITALIA				A
		II				SAARSCHMIEDE	VOLKINGEN				A
16	GENERATOR SHAFT MACHINING	I				SIEMENS AG	ERFURT				A
17	INSERT RING	II				SIEMENS AG	ERFURT				A
18	RETAINING RING	I				SIEMENS AG	ERFURT				A
19	MICA FLEECE&SPLITTING INSULATION TAPE	II				VON ROLL	OSTERREICH				A
		II				ISOVOLTA	SCHWEIZ				A
20	SILVER BEARING COPPER HOLLOW STRIPS (ROTOR COIL)	II				BUNTMETALL	OSTERREICH				A
21	FIELD LEAD CORE BAR FOR ROTOR AND EXCITOR	II				SIEMENS AG	ERFURT				A
22	TENSION BOLT FOR ROTOR	II				LAUMEN	MULHEIM				A
		II				HELLER	ARNSTADT				A
		II				STAHLBERG	LANGENFELD				A

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Patratu Vidyut Utpadan Nigam Limited C&M Deptt. Distt-Ramgarh(Jharkhand)

एनटीपीसी NTPC	PROJECT: Patratu Stage I Package: STEAM TURBINE GENERATOR CONTRACTOR: SIEMENS AG CONT_NO:	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUBCONTRACTOR APPROVAL SUB SYST GENERATOR AND AUX	Ref No: IN1141 000 Revision No: 00 Date: 12-10-2016

SR. NO	ITEM	QP /INS-PN CAT*	QP NO. 3530-110	QP SUB-MISSION SCHEDULE	QP APPL SCHED ULE	PROPOSED SUB SUPPLIER	PLACE	SS APPL STATUS / CAT	SS DETAIL SUB-SCHED ULE	SS APPL SCHED ULE	APPROVAL STATUS
23	CURRENT CARRYING BOLTS FOR ROTOR	II				GEILTZENAUR	DUISBURG/ GERMANY				A
24	ROTOR COIL FORMING	II				SIEMENS AG	MUELHEIM				A
25	WEDGES FOR ROTOR	II				BUNTMETALL KME	OSTERREICH GERMANY				A
26	ROTOR SLOT ANGLE	II				VON ROLL	GERMANY				A
		II				MICAFIL	SCHWEIZ				A
27	ROTOR WINDING ASSLY (GEN) INCL ROTOR SLOT ANGLE	II				SIEMENS AG	MUELHEIM				A
28	GENERATOR ROTOR-FINAL	I				SIEMENS AG	MUELHEIM				A
29	FAN BLADE FOR COMPRESSOR	II				STORK TURBO	HOLLAND				A
		II				MF-ENERGY	TCHECHIEN				A
		II				SET	UNGARN				A
30	COMPRESSOR HUB ASSEMBLY	II				SIEMENS AG	ERFURT				A
31	TERMINAL BUSHING (CONDENSER TYPE)	II				HSP	KOELN				A
32	TERMINAL BOX	II				ENERGY EN	SOUTH KOREA				A*
		II				TURBOCARE	POLAND				A
		II				ANDITZ	UNGARN				A
33	END SHIELD FABRICATION MACHINING	II				TURBOCARE	POLLAND				A

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एनटीपीसी NTPC

PROJECT: Patratu Stage I
Package: STEAM TURBINE GENERATOR
CONTRACTOR: SIEMENS AG
CONT_NO:

LIST OF ITEMS REQUIRING QUALITY PLAN AND SUBCONTRACTOR APPROVAL

SUB SYST GENERATOR AND AUX

Ref No: IN1141 000
Revision No: 00
Date: 12-10-2016

SR. NO	ITEM	QP /INS--PN CAT*	QP NO. 3530-110	QP SUB-MISSION SCHEDU-LE	QP APPL SCHED ULE	PROPOSED SUB SUPPLIER	PLACE	SS APPL STATUS / CAT	SS DETAIL SUB-SCHED ULE	SS APPL SCHED ULE	APPROVAL STATUS
33	END SHIELD FABRICATION MACHINING	II				ENERGYN EN	SOUTH KOREA				A*
		II				ANDITZ	UNGARN				A
34	BEARING SHELL	II				GLEITLAGER TECHNIK	ESSEN				A
35	SHAFT SEALING AND BEARING SHIELD	II				GLEITLAGER TECHNIK	ESSEN				A
		II				DIETERMANN	VIERSEN				A
36	WATER BOX FOR STATOR BAR	II				SIEMENS AG	ERFURT				A
37	HIGH PRESSURE HOSES FOR BEARING PEDESTAL	II				HTO	OBERHAUSEN				A
38	INSULATING HOSE LINE FOR PRIMARY WATER	II				CRANE RESISTOFLEX	PFORZHEIM				A
		II				DR SCHNABEL	PFORZHEIM/ GERMANY				A
39	P W TANK INCLUDING PW PIPING	II				EICKHOFF	MULHEIM				A
40	CARBON & CARBON BRUSH HOLDER	II				CARLS	ESSEN				A
		II				SCHUNK	WETTERNBERG				A
41	HYDROGEN COOLER	II				KELVION	HERNE				A
42	GENERATOR ASSEMBLY	I				SIEMENS AG	MUELHEIM				A

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Patratu Vidyut Utpadan Nigam Limited C & M Deptt. P.V.U.N.L. Deptt. Ramgarh (Jharkhand)

SIEMENS AG Signature

एनटीपीसी NTPC	PROJECT: Patratu Stage I Package: STEAM TURBINE GENERATOR CONTRACTOR: SIEMENS AG CONT_NO:	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUBCONTRACTOR APPROVAL SUB SYST GENERATOR AND AUX	Ref No: IN1141 000 Revision No: 00 Date: 12-10-2016

SR. NO	ITEM	QP /INS-PN CAT.	QP NO. 3530-110	QP SUB-MISSION SCHEDULE	QP APPL SCHED ULE	PROPOSED SUB SUPPLIER	PLACE	SS APPL STATUS / CAT	SS DETAIL SUB-SCHED ULE	SS APPL SCHED ULE	APPROVAL STATUS
43	GENERAOR TEST FIELD RUN (FINAL)	I				SIEMENS AG	MUELHEIM				A
44	ROTOR FLUX DENSITY MANITORING					SUPPLIER SHALL BE PROPOSED DURING DETAIL EXECUTION PHASE					
45	FLAT SPRING(FRAME)	II				TURBOCARE	POLAND				A
		II				ANDRITZ	UNGARN				A
		II				ENERGYN EN	SOTH KOREA				A

A* DETAIL EXPERIENCE REQUIRED. *- SIEMENS WILL FURNISH THE NAME OF THRE REGULAR SUPPLIER AND LOCATION PRIOR TO AWARD TO SUB VENDOR. A MEANS APPROVED.

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एनटीपीसी NTPC	PROJECT: PATRATU STPP (3X800 MW)	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUBCONTRACTOR APPROVAL PACKAGE	REF. NO.: CS-9585-001-02
	PACKAGE: STEAM GENERATOR ISLAND (ESP)		REV. NO.: 00
	CONTRACTOR: BHEL	SUB-SYSTEM: BHEL RANIPET, ISG	
	CONTRACT NO.: CS-9585-001-02		DATE: 04.04.2017

SL. NO.	ITEM	QP/ INSP. CAT.	QP. NO.	QP. SUBMISSION SCHEDULE	QP APPL. SCHEDULE	PROPOSED SUB SUPPLIER	PLACE	SS APPL/ STATUS/ CAT	SS DETAIL SUB SCHEDULE	SC APPL. SCHEDULE	REMARKS
1	HVR TRANSFORMER AND EC PANEL	I				BHEL	JHANSI/ BHOPAL	A			SUB-QR ITEM
2	BUSHING INSULATOR	II				BHEL EPD	BANGALORE	A			
3	SHAFT INSULATOR	II				BHEL EPD	BANGALORE	A			
4	SUPPORT INSULATOR	II				BHEL EPD	BANGALORE	A			
5	ASH LEVEL INDICATOR	II				FLOWSTAR	FARIDABAD	A			
		II				NIVO CONTROLS	INDORE	A			
		II				EIP ENVIROLEVEL	NOIDA	A			
		@				BHEL	RANIPET	DR			
6	ESP CONTROLLER (ARECA, INTELLIR AP, STATCON)	III				ADVANCED ELECTRONICS (ALS)	BANGALORE	A			
		III				SYSTEM AIDS	BANGALORE	A			
		III				VASANTHA ADVANCED SYSTEM	COIMBATORE	A			
		III				EM ELECTRONICS	BANGALORE	A			
7	INTELLIRAP STATCON & IOS PANEL	I				CHEMIN CONTROLS	PONDICHERY	A			
		I				BHEL EPD	BANGALORE	A			
		I				CONTROL AND SCHEMATICS	HYDERABAD	A			
		I				PRAMEEN INDUSTRIES	PUDUKOTT	A			
		I				CONTROL AND SWITCHGEAR	HYDERABAD	A			
		I				INDUSTRIAL CONTROL AND APPLIANCES	MUMBAI	A			
		@				SAJAS ELECTRICAL	TRICHY	DR			
		@				SHIBSHA INSTRUMENTS	CHENNAI	DR			
		@				COMPUTER CONTROL OPERATIONS	PONDICHERRY	DR			
		@				KEAS CONTROL SYSTEMS INDIA PVT. LTD.	COIMBATORE	DR			
8	OPACITY MONITOR	III				SICK	GERMANY	A			Minor items like canopy etc will be manufactured in India and supplied by Indian Representatives
		III				DURAG	GERMANY	A			Minor items like canopy etc will be

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Patratu Vidyut Utpadan Nigam Limited Distt-Ramgarh/Jharkhand C & M Deptt.

4/4/17 R. ARUMUGAM

ENGINEERING DIV/ QA&I

एनटीपीसी NTPC	PROJECT: PATRATU STPP (3X800 MW)	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUBCONTRACTOR APPROVAL PACKAGE	REF. NO.: CS-9585-001-02
	PACKAGE: STEAM GENERATOR ISLAND		REV. NO.: 00
	CONTRACTOR: BHEL	SUB-SYSTEM: BHEL RANIPET, ISG	
	CONTRACT NO.: CS-9585-001-02		DATE: 04.04.2017

SL. NO.	ITEM	QP/ INSP. CAT.	QP. NO.	QP. SUBMISSION SCHEDULE	QP APPL. SCHEDULE	PROPOSED SUB SUPPLIER	PLACE	SS APPL/ STATUS/ CAT	SS DETAIL SUB SCHEDULE	SC APPL. SCHEDULE	REMARKS
											manufactured in India and supplied by Indian Representatives
		III				CODEL	UK	A			THROUGH FORBES MARSHALL – PUNE Minor items like canopy etc will be manufactured in India and supplied by Indian Representatives
		III				LAND COMBUSTION	UK	A			Minor items like canopy etc will be manufactured in India and supplied by Indian Representatives
						DURAG INDIA INSTRUMENTATION PVT. LTD.	BENGALURU	DR			
9	HEATER (PANEL TYPE HOPPER HEATERS)	I				HTD HEAT TRACE INDIA	HYDERABAD	A			
		II				HOT FOIL EHS INC	USA	A			
		II				HTD HEAT TRACE	USA	A			For panel type hopper heaters, the mounting accessories will be manufactured in India and will be supplied by the Indian representatives
		II				THERMON	USA	A			
		I				THERMOPADS	HYDERABAD	A*			*APPROVED SUBJECT TO SUCCESFUL EXECUTION OF TRIAL ORDER
		I				THERMON	PUNE	A			
10	ELEVATOR	I				ECE	GHAZIABAD	A			
		I				TECHNO	AHMEDABAD	A			
		I				OTIS	MUMBAI	A			
		I				KONE	CHENNAI	A			
		I				OMEGA	AHMEDABAD	A			
		I				SAMIL ELTEC	KOREA	A			

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Patratu Vidyut Utpadan Nigam Limited C & M Deptt. Dist-Ramgarh, Jharkhand

4/4/17

ENGINEERING DIV/ QA&I

एनटीपीसी NTPC	PROJECT: PATRATU STPP (3X800 MW)	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUBCONTRACTOR APPROVAL PACKAGE	REF. NO.: CS-9585-001-02
	PACKAGE: STEAM GENERATOR ISLAND		REV. NO.: 00
	CONTRACTOR: BHEL	SUB-SYSTEM: BHEL RANIPET, ISG	
	CONTRACT NO.: CS-9585-001-02		DATE: 04.04.2017

SL. NO.	ITEM	QP/ INSP. CAT.	QP. NO.	QP. SUBMISSION SCHEDULE	QP APPL. SCHEDULE	PROPOSED SUB SUPPLIER	PLACE	SS APPL/ STATUS/ CAT	SS DETAIL SUB SCHEDULE	SC APPL. SCHEDULE	REMARKS
11	LT MOTORS (REFER NOTE 1)	I				KEC	BANGALORE/HUBLI	A			HUBLI UPTO 90 KW, RQP
		I				SIEMENS	MUMBAI	A			RQP
		I				CGL	AHMEDNAGAR	A			RQP
		I				MARATHON	KOLKATA	A			RQP
		I				BBL	MUMBAI	A			RQP
		I				ABB	FARIDABAD/ BANGALORE	A			FARIDABAD UPTO 55 KW, BANGALORE ABOVE 55 KW, RQP
		I				JYOTI	VADODARA	A			
		I				LHP	SOLAPUR	A			
						NGEF	HUBLI	A			UPTO 15 KW
11	XLPE/ PVC INSULATED LT POWER CABLES					REFER SEPARATE LIST					
12	PVC INSULATED LT CONTROL CABLES					REFER SEPARATE LIST					
13	SCREENED (INSTRUMENT) CABLES	I				POLYCAB	DAMAN	A			
		I				ELKAY TELELINKS	FARIDABAD	A			
		I				ADVANCE CABLES	BANGALOR E	DR			
		I				PARAMOUNT	KHUSKHERA	A			
		I				UNIVERSAL	SATNA	A			
		I				NICCO	KOLKATA	A			
		I				DELTON	FARIDABAD	A			
		I				INCAB	PUNE	A			

Bharat Heavy Electricals Limited PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited * Distt-Ramgarh (Jharkhand) C & M Deptt

4/4/17

ENGINEERING DIV/ QA&I

एनटीपीसी NTPC	PROJECT: PATRATU STPP (3X800 MW)	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUBCONTRACTOR APPROVAL PACKAGE	REF. NO.: CS-9585-001-02
	PACKAGE: STEAM GENERATOR ISLAND		REV. NO.: 00
	CONTRACTOR: BHEL	SUB-SYSTEM: BHEL RANIPET, ISG	
	CONTRACT NO.: CS-9585-001-02		DATE: 04.04.2017

SL. NO.	ITEM	QP/ INSP. CAT.	QP. NO.	QP. SUBMISSION SCHEDULE	QP APPL. SCHEDULE	PROPOSED SUB SUPPLIER	PLACE	SS APPL/ STATUS/ CAT	SS DETAIL SUB SCHEDULE	SC APPL. SCHEDULE	REMARKS
		I				THERMO CABLES	HYDERABAD	A			
		I				KEI	BHIWADI	A			
		I				CORDS	BHIWADI	A			
		I				GUPTA POWER INFRASTRUCTURE LTD.	KHURDA	A			
		@				CMI	BHIWADI	DR			
		@				SPECIAL CABLES	RUDRAPUR	DR			
		@				KEC	MYSORE	DR			
14	RTD AND THERMOCOUPLE ALONG WITH THERMOWELL	II				THERMAL INSTRUMENT INDIA PVT. LTD	MUMBAI/ SAVANTWADI	A			
		II				TEMPSENS INSTRUMENT (I) PVT. LTD.	UDAIPUR	A			
		II				DETRIV INST & ELEC LTD	MUMBAI	A			
		II				PYRO ELECTRIC INSTRUMENT (GOA) PVT. LTD,	GOA	A			
		II				TECHNO INSTRUMENT	AHMEDABAD	A			
		@				GOA INSTRUMENT PVT. LTD.	GOA	DR			
		@				TOSHNIWAL INDUSTRIAL PVT. LTD.	AJMER	DR			
		@				BAUMER TECHNOLOGIES INDIA PVT. LTD.	VAPI	DR			
15	AUXILIARY CONTROL PANEL/ LTMSB					REFER SEPARATE LIST					
16	ELECTRICAL ACTUATOR (WITH GEAR BOX	II				DREHMO	GERMANY				

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एनटीपीसी NTPC	PROJECT: PATRATU STPP (3X800 MW)	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUBCONTRACTOR APPROVAL PACKAGE	REF. NO.: CS-9585-001-02
	PACKAGE: STEAM GENERATOR ISLAND		REV. NO.: 00
	CONTRACTOR: BHEL	SUB-SYSTEM: BHEL RANIPET, ISG	
	CONTRACT NO.: CS-9585-001-02		DATE: 04.04.2017

SL. NO.	ITEM	QP/ INSP. CAT.	QP. NO.	QP. SUBMISSION SCHEDULE	QP APPL. SCHEDULE	PROPOSED SUB SUPPLIER	PLACE	SS APPL/ STATUS/ CAT	SS DETAIL SUB SCHEDULE	SC APPL. SCHEDULE	REMARKS
	ALSO)										
		II				AUMA	GERMANY	A			
		II				ROTORK	CHENNAI/ BANGALORE	A			
		II				ROTORK	UK	A			
		II				LIMITORQUE	FARIDABAD	A			
		II				AUMA INDIA	BANGALORE	A			
17	CABLE TRAYS AND ACCESSORIES					REFER SEPARATE LIST					
18	FLEXIBLE CABLE TRAY SUPPORT					REFER SEPARATE LIST					
19	CABLE GLANDS					REFER SEPARATE LIST					
20	CABLE LUGS					REFER SEPARATE LIST					
21	GEARED MOTOR	III				SHANTI GEARS LTD	COIMBATORE	A			
		III				NEW ALLENBERY WORKS	KOLKATA	A			
		III				LAXMI HYDRAULIC PVT. LTD.	SHOLAPUR	A			
		III				POWERBUILD	VV NAGAR	A			
22	DISCONNECTING SWITCH FOR ESP	III				BHEL APPROVED VENDORS					INSULATOR MAKE SHALL BE BHEL/ WSI/ JSI/ UCE/ ADITYA BIRLA
23	HEATING ELEMENT (TUBULAR) FOR ESP	III				BHEL APPROVED VENDORS					
24	JUNCTION BOXES (GALVANISED) FOR ESP					REFER SEPARATE LIST					
25	INTERLOCKS FOR ESP	III				BHEL APPROVED VENDORS					
26	EARTHING MATERIALS (GI FLATS) FOR ESP					REFER SEPARATE LIST					
27	PERSONNEL COMPUTER FOR ESP	III				BHEL APPROVED VENDORS					

Bharat Heavy Electricals Limited PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited C & M Deptt. Distt-Ramgarh (Jharkhand)

4/4/17

ENGINEERING DIV/ QA&I

एनटीपीसी NTPC	PROJECT: PATRATU STPP (3X800 MW)	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUBCONTRACTOR APPROVAL PACKAGE	REF. NO.: CS-9585-001-02
	PACKAGE: STEAM GENERATOR ISLAND		REV. NO.: 00
	CONTRACTOR: BHEL	SUB-SYSTEM: BHEL RANIPET, ISG	
	CONTRACT NO.: CS-9585-001-02		DATE: 04.04.2017

SL. NO.	ITEM	QP/ INSP. CAT.	QP. NO.	QP. SUBMISSION SCHEDULE	QP APPL. SCHEDULE	PROPOSED SUB SUPPLIER	PLACE	SS APPL/ STATUS/ CAT	SS DETAIL SUB SCHEDULE	SC APPL. SCHEDULE	REMARKS
28	PRINTER FOR ESP	III				BHEL APPROVED VENDORS					
29	THERMOSTAT FOR ESP	III				BHEL APPROVED VENDORS					
30	LOCAL START/ STOP PUSH BUTTON STATION FOR ESP					REFER SEPARATE LIST					
31	LIMIT SWITCH WITH LEVER FOR GATES & DAMPERS	III				BHEL APPROVED VENDORS					
32	JUNCTION BOXES FOR GATES & AMPERS	III				BHEL APPROVED VENDORS					
33	OTHER ITEMS LIKE PC TERMINATION BOX, PC ADD ON CARD SIMULATOR FOR ARECA, COMCON INTERFACE MODULE, PC	III				BHEL APPROVED VENDORS					
34	FQP FOR ELECTRICAL ITEMS	I				BHEL	RANIPET				

Note 1 : a) Acceptance of Motor less than 30 KW is based on COC of the manufacturer and the contractor confirming as follows: It is hereby confirmed that the above mentioned motor /motors was/ were manufactured taking care of NTPC specific requirements regarding ambient temp., voltage and frequency variation, hot starts, pull out torque, starting KVA/KW, temp. rise, distance between centre of stud and gland plate and tested in accordance with approved drawing /data sheets b) 30 KW and above Acceptance of Motor rating between 30 KW 50 KW is based on NTPC review of Routine Test Inspection report as per IS 325 witnessed by main contractor along with COC of the manufacturer and the contractor confirming as follows: It is hereby confirmed that the above mentioned motor /motors was/ were manufactured taking care of NTPC specific requirements regarding ambient temp., voltage and frequency variation, hot starts, pull out torque, starting KVA/KW, temp. rise, distance between centre of stud and gland plate, space heater and tested in accordance with approved drawing /data sheets. Above 50 KW up to 200 KW NTPC Inspection as per approved QP.

Note 3: Misc items like name plate, cable laying accessories, cable tags, cable dressing, material, wire, marker, clamps and pads for thermocouple adaptor, union, cross, socket and plug, pneumatic fittings tubes shall be as per BHEL system.

Note 4: NTPC Approval conditions for all approved vendors shall be complied.

Note 5: @ - Inspection category will be decided during vendor evaluation.

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ENGINEERING DIV/ QA&I

एनटीपीसी NTPC	Project : 3x800 MW PATRATU STPP (Phase-I) Package : EPC Pkg- Oil Filled Transformers (GT, Reactor, ST, SBT, UT, Auxiliary Transformer, Maintenance Equip), GCB, Dry Type Transformer, IPBD, SPBD, .) Supplier : BHEL Contract No.: CS-9585-001-2	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB-SUPPLIER APPROVAL	Doc.No 9585-001-QOE-R-00 REV.NO. : 0 DATE : 27.04.2017 PAGE : 1 OF 5

S.N.	Item Description	QP/ Insp. Cat	QP # 9585-001-QVE-	QP Sub. Schedule	QP Approval Schedule	Proposed sub-supplier	Place	Sub-supplier approval status / cat	Sub-supplier Details submission schedule	Remark
1	OIL FILLED POWER TRANSFORMER (Above 72.5 kV & UP TO 400 kV Class) L1 Level Vendor (Refer Note 4 & 5)	I	Q-001			ALSTOM	ALLAHABAD	A		
						ABB	VADODARA	A		
						SIEMENS	NAVI MUMBAI	A		
						EMCO	THANE	A		
						BHEL	BHOPAL	A		
						BHEL	JHANSI	A*		*Upto 220kV class only
						CGL	KANJUR MARG	A		
						GE T&D	VADODARA	DR		
						TELK	AGNAMALLY	A		
2	DRY TYPE TRANSFORMER L1 Level Vendor (Refer Note 4)	I	Q-002			ABB	Savli	A		up to 8 MVA, 24 kV Class
						Raychem	Pune	A		Up to 3.5 MVA, 33 kV Class
						Toshiba	Hyderabad	A		Up to 2.0 MVA, 33 kV Class
						BHEL	Jhansi	A		Up to 6.3 MVA, 33 kV Class
						Kirloskar	Pune	A		Up to 4.0 MVA, 33 kV Class
						Voltamp	Savli	A		Up to 3.25 MVA, 33 kV Class
3	OIL FILLED SERVICE / AUX TRANSFORMER (≤72.5 kV Class) L1 Level Vendor (Refer Note 4 & 5)	I	Q-003			MARSONS LTD	KOLKATA	DR		
						UNIVERSAL POWER TRF	BANGALORE	DR		
						BHEL	JHANSI	A		
						Kirloskar	Mysore	A		up to 16 MVA, 33 kV Class
						KRYFS POWER COMPONENT	SILVASA	A		Up to 2.5 MVA, 33 kV Class
						SCHNEIDER	VADODARA	A		Up to 50MVA, 132 kV Class
						SOUTHERN POWER	BANGALORE	DR		
						EMCO	JALGAON	A		Up to 16 MVA, 33 kV Class
						DANISH PVT LTD	JAIPUR	DR		
						ESENNAR TRFSFORMERS	MEDAK	A		Up to 16 MVA, 33 kV Class
						T & R (INDIA) LTD.	AHMEDABAD	A		Up to 16 MVA, 132 kV Class
						VOLTAMP TRANSFORMERS	SAVLI	A		UPTO 3.5 MVA, 33KV
						TESLA TRANSFORMERS (U-2)	BHOPAL	A		UP TO 5 MVA, 33 KV
						KANOHAR ELECTRICALS LTD.	MEERUT	A		Upto 16 MVA, 33 kV Class
4	NEUTRAL GROUNDING REACTOR L1 Level Vendor (Refer Note 4)	I	Q-004			QUALITY POWER	SANGLI	A		
						BHEL	BHOPAL	A		
						SHRIHANS ELECTRICAL	RAIGAD	DR		
5	SHUNT REACTOR (400 kV Class) L1 Level Vendor (Refer Note 4 & 5)	I	Q-005			ABB Ltd. (MPT/LPT)	Vadodara	A		
						BHEL	Bhopal	A		
						SIEMENS	NAVI MUMBAI	A		
						TBEA	VADODARA	DR		
						GE T&D	Naini	A		
						CGL	Kanjurmarg	A		
6	NEUTRAL GROUNDING RESISTOR L1 Level Vendor (Refer Note 4)	I	Q-006			RSI SWITCHGEAR PVT. LTD.	KOLKATA	A		
						S.R.NARKHEDE	PUNE	A		
						LACHHMAN ELECTRONICS	NEW DELHI	A		
						RESITECH ELECTRICALs	KOLKATA	A		
						AMPCONTROL EQUIPMENTS	PUNE	A		

Bharat Heavy Electricals Limited PS-MKTG Delhi

Amarlu 27/04/17 (Aman Pandey) NTPC

Patratu Vidyut Utpadan Nigam Limited (Jharkhand) C & M Deptt.

Adav, Amit Yadav mgr/PS-MKTG. BHEL

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एनटीपीसी NTPC	Project : 3x800 MW PATRATU STPP (Phase-I) Package : EPC Pkg- Oil Filled Transformers (GT, Reactor, ST, SBT, UT, Auxiliary Transformer, Maintenance Equip), GCB, Dry Type Transformer, IPBD, SPBD, .) Supplier : BHEL Contract No.: CS-9585-001-2			LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB-SUPPLIER APPROVAL					Doc.No:9585-001-QOE-R-00 REV.NO. : 0 DATE : 27.04.2017 PAGE : 2 OF 5		
S.N.	Item Description	QP/ Insp. Cat	QP # 9585-001-QVE-	QP Sub. Schedule	QP Approval Schedule	Proposed sub-supplier	Place	Sub-supplier approval status / cat	Sub-supplier Details submission schedule	Remark	
7	NEUTRAL GROUNDING TRANSFORMER L1 Level Vendor (Refer Note 4)	I	Q-007			PRAGATI ELECTRICALS	THANE	A			
						PRAYOG ELECTRICALS	PUNE	A			
						PETE	HYDERABAD	A			
						VOLTAMP	SAVLI	A			
						KANOHAR ELECTRICALS LTD.	MERRUT	A			
						CGL	MALANPUR	A			
						TESLA TRANSFORMERS (U-2)	BHOPAL	A			
						TOSHIBA	HYDERABAD	A			
						T & R (INDIA) LTD.	AHMEDABAD	A			
						PS ELECTRICALS	CHENNAI	DR			
8	MV Busduct (IPBD & SPBD) L1 Level Vendor (Refer Note 4 & 5)	I	Q-008			BHEL	RUDRAPUR	A			
						C&S	NOIDA/HARDWAR	A			
						POWERGEAR	CHENNAI/HINDUPUR	A			
9	ON LINE DGA ANALYZER	III	*			GE Kelman Ltd	UK	A			
						Serveron	USA	A			
						DOBLE	USA	DR			
						GE SYPROTECH	Canada	DR			
						Hydran	Canada	DR			
						MTE	SwitzerLand	DR			
						NLGOM	China	A			
						A-eberle (EMH EncRGIE)	Germany	A			
						Morgan Scehalfer	Canada	A			
10	OIL BDV MEASUREMENT KIT	III	*			Tettex	SwitzerLand	A			
						Volkommen	Germany	DR			
						Hasfely Test AG	SwitzerLand	DR			
						H Tinsley	UK	DR			
						Megger	USA / UK	A		Main Contractor to obtain prior approval from NTPC for the Model of equipment they intent to supply, before placing order	
						HVDSA	SwitzerLand	DR			
						Shivananda	Nashik	A			
11	OIL TAN DELTA AND RESISTIVITY MEASURMENT KIT	III	*			Megger	USA/UK	A			
						Eltel Industries	Bangalore	A			
						Hafely	USA	A			
						Doble	USA	DR			
						Appareils Vettiner	France	DR			
						Volkommen	Germany	DR			
						Tinsley	UK	A			
						AVO	UK	A			
12	DEW POINT MEASURMENT INSTRUMENT	III	*			Alpha Moisture	UK	A			
						Vaisala	Finland	A			
						Doble	USA	A			
						Cryo Industries	USA	A			

Bharat Heavy Electricals Limited PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited Distt-Ramgarh(Jharkhand) C & M Deptt.

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एनटीपीसी NTPC	Project : 3x800 MW PATRATU STPP (Phase-I) Package : EPC Pkg- Oil Filled Transformers (GT, Reactor, ST, SBT, UT, Auxiliary Transformer, Maintenance Equip), GCB, Dry Type Transformer, IPBD, SPBD, .) Supplier : BHEL Contract No.: CS-9585-001-2	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB-SUPPLIER APPROVAL	Doc.No:9585-001-QOE-R-00 REV.NO. : 0 DATE : 27.04.2017 PAGE : 3 OF 5

S.N.	Item Description	QP/ Insp. Cat	QP # 9585-001-QVE-	QP Sub. Schedule	QP Approval Schedule	Proposed sub-supplier	Place	Sub-supplier approval status / cat	Sub-supplier Details submission schedule	Remark
13	FRA TEST KIT	III	*			Doble	USA	A		
						Haefely	SwitzerLand	DR		
						Omicron	Hongkong	DR		
						HP (Allient)	USA	A		
						Tettex	USA	A		
						Megger	Sweden	A		
14	CAPCITANCE & TAN DELTA MEASUREMENT KIT	III	*			Megger	USA	A		
						Andeen Hagerling	USA	A		
						Doble	USA	A		
						Hafely	France/Switzerland	A		
						Tettex	USA	A		
15	TRANSFORMER TURNS RATIO (TTR) MEASUREMENT KIT	III	*			Tinsley	UK	A		
						Tettex	SwitzerLand	A		
						Haefely	SwitzerLand	DR		
						Sivananda Electronis	Nashik	DR		
						Megger	USA / UK	A		
						DV Power	Sweden	A		
16	WINDING RESISTANCE MEASURMENT KIT	III	*			Eltel	Bangalore	A		
						Megger	USA	A		
						Shivananda	Nashik	DR		
						IBEKO	Sweden	A		
						DV Power	Sweden	A		
						Scope T&M	Pune	A		Main Contractor to obtain prior approval from NTPC for the Model of equipment they intent to supply, before placing order
17	OFF LINE LABORATORY MODEL OIL DGA KIT	III	*			GE Kelmen Ltd	UK	A		
						Perkin Elmer	Germany	DR		
						GE SYPROTECH	Canada	DR		
						Hydran	Canada	DR		
						CIC	Vadodara	A		
						Agilent	USA	DR		
						Brucker	USA	A		
18	HYDRAULIC JACKING SYSTEM	III	*			Enerpack Hydraulic	Vasai, Mumbai	A		
						Bemco Jackas & Allied Products	Belgaon	A		
						Ketoo	Japan	A		
						Hydro Pack	Belgaon	A		
						Oriental Engg Works	Yamunanagar	A		
						Venkos & Co	Patna	A		
19	ON LINE MOITURE REMOVAL SYSTEM	III	*			Transec	UK	A		
						Dry Keep	USA	DR		
						Velcon	USA	DR		
						Ravin Infra	Pune	A	Conditions Apply	
						CEE DEE VACUUM EQUIPMENTS PVT LTD	PUNE	A	Conditions Apply	
						PTSS	Combaitore	A		
						Dry Keep	South Africa	A		

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Patratu Vidyut Utpadan Nigam Limited ★ Distt-Ramgarh(Jharkhand) ★ C & M Deptt.

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एनटीपीसी NTPC	Project : 3x800 MW PATRATU STPP (Phase-I) Package : EPC Pkg- Oil Filled Transformers (GT, Reactor, ST, SBT, UT, Auxiliary Transformer, Maintenance Equip), GCB, Dry Type Transformer, IPBD, SPBD, .) Supplier : BHEL Contract No.: CS-9585-001-2	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB-SUPPLIER APPROVAL	Doc.No:9585-001-QOE-R-00 REV.NO. : 0 DATE : 27.04.2017 PAGE : 4 OF 5

S.N.	Item Description	QP/ Insp. Cat	QP # 9585-001-QVE-	QP Sub. Schedule	QP Approval Schedule	Proposed sub-supplier	Place	Sub-supplier approval status / cat	Sub-supplier Details submission schedule	Remark
20	VACUUM PUMP WITH MOTOR	III	*			Vacuunair	Ahmedabad	A		Main Contractor to obtain prior approval from NTPC for the Model of equipment they intent to supply, before placing order
						Tuthill Pneumatics Group	USA	A		
						Shinko Seiki	Japan	A		
						Orlikon	Germany	A		
						Kakati	Hyderabad	A		
						Gardner Denver Nash	China	A		
21	OIL TANKER, WHEEL MOUNTED	II	Q-009			VPI	Pune	A		
						CEEDEE Vacuum	Pune	A		
						Satyam Industries	Bhopal	A		
						Mechman	Bhopal	A		
						Jyoti Fab	ALLAHABAD	A		
						Electromech (U-2)	Bhopal	A		
						Jagdamba Tools	Vadodara	DR		
						Fowler Westrup (India) Pvt Ltd	Bangalore	A		
22	Dielectric Response Analyzer	III	*			Iris Power (Qualitrol)	Canada	DR		
						Megger	Sweden	DR		
						Omicron	Austria	DR		
23	OIL PURIFYING EQUIPMENT	I	Q-010			VPI	Pune	A		
						CEEDEE Vacuum	Pune	A		
						Fowler Westrup	Bangalore	A		
24	OFAF COOLER	II	Q-011			LUVATA	Sweden	A		
						Unifin	Canada	DR		
						Serk Heat Transfer	UK	DR		
						ABB	Sweden	A		
						GEA	China	A		
						BHEL	Bhopal	A		
						Asha Bhanu Tech Services	Hyderabad	A		
						Fitwell	Bhopal	A		
25	COMPOSITE MONITORING SYSTEM	III	*			Dyanamic Ratings	USA	A		1) Main Contractor to obtain prior approval from NTPC for the Model of equipment they intent to supply, before placing order. 2) As per approval conditions.
						A-eberle	Germany	A		
						BHEL	Bhopal	A		
						MR	Germany	DR		
						GE Grid	Germany	DR		
						Siemens	Navi Mumbai	A		
26	Enclosure for CMS System	II	Q-.012			BHEL	Bhopal	A		
						Rittal	Bangalore	A		
						Pyrotech	Udaipur	A		
						Maktel	Vadodara	A		
27	GENERATOR CIRCUIT BREAKER L1 Level Vendor (Refer Note 4 & 5)	I	Q-140			GRID Solutions SAS	FRANCE	DR		
						ABB SWITZERLAND LTD.,	SWITZERLAND	A		

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Patratu Vidyut Utpadan Nigam Limited Distt-Ramgarh(Jharkhand) C & M Deptt.

A Yadav

एनटीपीसी NTPC	Project : 3x800 MW PATRATU STPP (Phase-I) Package : EPC Pkg- Oil Filled Transformers (GT, Reactor, ST, SBT, UT, Auxiliary Transformer, Maintenance Equip), GCB, Dry Type Transformer, IPBD, SPBD, .) Supplier : BHEL Contract No.: CS-9585-001-2			LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB-SUPPLIER APPROVAL					Doc No:9585-001-QOE-R-00 REV.NO. : 0 DATE : 27.04.2017 PAGE : 5 OF 5	
S.N.	Item Description	QP/ Insp. Cat	QP # 9585-001-QVE-	QP Sub. Schedule	QP Approval Schedule	Proposed sub-supplier	Place	Sub-supplier approval status / cat	Sub-supplier Details submission schedule	Remark
28	FQP FOR OIL FILLED TRFs	I	G-001			BHEL		A		
29	FQP FOR GCB	I	G-002					A		
30	FQP FOR SHUNT REACTOR	I	G-003					A		
31	FQP FOR NGT	I	G-004					A		
32	FQP FOR DRY TYPE TRF	I	G-005					A		
33	FQP FOR MV BUSDUCT	I	G-006					A		
34	WPS FOR TRF TANK	I	W-001					A		
35	WPS FOR BUSDUCT	I	W-002					A		

NOTE:

1. SYSTEM SUPPLIERS/SUB-SUPPLIERS APPROVAL STATUS CATEGORY(SHALL BE FILLED BY NTPC)
   A-For this items proposed vendor is acceptable to NTPC.To be indicated with letter "A" in the list along with condition of approval,if any
   DR-For these items "Detailed required for NTPC review.To be identified with letter "DR" in the list.
   NOTED- For these items vendors are approved by Main Supplier & accepted by NTPC without specific vendor approval from NTPC.To be identified with "NOTED".
2. QP / INSPN CATEGORY
   CAT-I :For these items the Quality Plans approved by NTPC & final acceptance will be on physical inspection witness by NTPC
   CAT-II :For these items the Quality Plans approved by NTPC.However no physical inspection shall be done by NTPC.The final acceptance by NTPC shall be on basis of documents as per approved QP
   CAT-III :For these items Main supplier approves the Quality Plans.The final acceptance by NTPC shall be on basis of certificate of conformance by the main supplier.
   * :Control measure of item covered in quality plan of main item.
3. UNITS/WORKS : Place of manufacturing/ Place of Main Supplier of multi units/works.
4. Comprehensive L-2 list of sub-vendors shall be finalized with the finally selected L-1 vendor, but prior to order finalization on L-1 vendor by the Bidder.
5. Item Subjected to Sub-QR clearance

07/04/17

Bharat Heavy Electricals Limited PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited Distt-Ramgarh(Jharkhand) C & M Deptt.

एनटीपीसी NTPC	PROJECT: Patratu Super Thermal Power Station Expansion Phase-I (3x800MW) PACAKGE : EPC Sub Package : Solar roof top dedicated items CONTRACTOR : M/S BHEL CONT. NO.; CS-9585-001-02	LIST OF ITEMS REQUIRING QP APPROVAL & ACCEPTABLE VENDOR AS PROPOSED BY M/S BHEL	REF NO : 9585-001-QOE-R-01 REVISION NO. 00 DATE 26.04.2017

Sl. No.	ITEM	QP / INS CAT.	QP No:- 9585-001-QVE-	QP SUB. SCH.	QP APPL SCHEDULE	SUB-SUPPLIERS PROPOSED BY M/S L&T	PLACE	SUB-SUPPLIER APPL STATUS AS PER NTPC	SC APPL SCHEDULE	SC DETAIL SUB SCH	REMARKS
1.	SPV module	I	Q-01			BHEL	Bangalore	A@			@- Subject to Sub-QR clearance from NTPC Engg.
						Warree	Surat	A@			
						Emmvee	Bangalore	A@			
						Vikram Solar	Parganas	A@			
						Lanco Solar	Chattisgarh	A@			
						Tata Power Solar	Bangalore	A@			
						Alpex	Solan	A@			
						Synergy	Durgapur	A@			
						Photonix	Satara	A@			
						HHV Solar	Bangalore	A@			
						Moserbaer	Greater Noida	A@			
						REIL	Jaipur	DR			
2.	String Inverter	II	Q-01			Delta	China	A			Model- RPI-M10A, RPI-M15A, RPI-M20A, RPI-M30A, RPI-M50A
						Huawei	China	A			SUN2000 Series String Inverter
						Kaco	Germany	DR			
						Schneider	Bangalore	DR			
						ABB	Bangalore	DR			
3.	DC Cable (Interconnecting	II	Q-01			Siechem	Pondicherry	A			

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Patratu Vidyut Utpadan Nigam Limited * Distt-Ramgarh(Jharkhand) C & M Deptt.

(NTPC) (Bidder)

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एनटीपीसी NTPC	PROJECT: Patratu Super Thermal Power Station Expansion Phase-I (3x800MW) PACAKGE : EPC Sub Package : Solar roof top dedicated items CONTRACTOR : M/S BHEL CONT. NO.; CS-9585-001-02	LIST OF ITEMS REQUIRING QP APPROVAL & ACCEPTABLE VENDOR AS PROPOSED BY M/S BHEL	REF NO : 9585-001-QOE-R-01 REVISION NO. 00 DATE 26.04.2017

Sl. No.	ITEM	QP / INS CAT.	QP No:- 9585-001-QVE-	QP SUB. SCH.	QP APPL SCHE DULE	SUB-SUPPLIERS PROPOSED BY M/S L&T	PLACE	SUB-SUPPLIER APPL STATUS AS PER NTPC	SC APPL SCHED ULE	SC DETAIL SUB SCH	REMARKS
	SPV Modules, SPV Module to AJB) As per TUV specification 2 Pfg 1169/08.2007: subject to acceptance by Engg										
						Lapp	Korea	A			
						Leoni	Switzerland	A			
						Apar	Khatalwada	A			Conditions apply
4.	FQP for SPV Moddules	G-01									

Abbreviations

A – For these items proposed vendor is acceptable to NTPC. To be indicated with letter "A" in the list along with the condition of approval, if any.

DR – For these items "Detailed required" for NTPC review. To be identified with letter "DR" in the list.

QP/INSPECTION CATEGORY:

CAT-I : For these items the Quality Plans are approved by NTPC and the final acceptance will be on physical inspection witness by NTPC.

CAT-II : For these items the Quality Plans approved by NTPC. However no physical inspection shall be done by NTPC. The final acceptance by NTPC shall be on the basis review of documents as per approved QP.

CAT-III : For these items Main Supplier approves the Quality Plans. The final acceptance by NTPC shall be on the basis certificate of conformance by the main supplier.

General Notes:

1-Vendor list & category of the mandatory spares shall be as mentioned above.

2- For items not covered above, main contractor shall seek NTPC-QA's clearance before placing the order.

(NTPC)

(Bidder)

Bharat Heavy Electricals Limited PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited C & M Deptt. Distt-Ramgarh (Jharkhand)

एनटीपीसी NTPC	PROJECT: Patratu Super Thermal Power Station Expansion Phase-I (3x800MW) PACAKGE : EPC Sub Package : Solar roof top dedicated items CONTRACTOR : M/S BHEL CONT. NO.; CS-9585-001-02	LIST OF ITEMS REQUIRING QP APPROVAL & ACCEPTABLE VENDOR AS PROPOSED BY M/S BHEL	REF NO : 9585-001-QOE-R-01 REVISION NO. 00 DATE 26.04.2017

Sl. No.	ITEM	QP / INS CAT.	QP No:- 9585-001-QVE-	QP SUB. SCH.	QP APPL SCHE DULE	SUB-SUPPLIERS PROPOSED BY M/S L&T	PLACE	SUB-SUPPLIER APPL STATUS AS PER NTPC	SC APPL SCHED ULE	SC DETAIL SUB SCH	REMARKS

3- NTPC Approval conditions to above identified vendors shall be adhered to. Vendor's approval conditions will be informed on specific request of Main Contractor

Amit Yadav
Mgr/MKTG.
BHEL

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Patratu Vidyut Utpadan Nigam Limited Distt-Ramgarh(Jharkhand) C & M Deptt.

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एनटीपीसी NTPC	PROJECT: Patratu Super Thermal Power Station Expansion Phase-I (3x800MW) PACAKGE : EPC Sub Package : HT Switchgear dedicated Items CONTRACTOR : M/S BHEL CONT. NO.; CS-9585-001-02	LIST OF ITEMS REQUIRING QP APPROVAL & ACCEPTABLE VENDOR AS PROPOSED BY M/S BHEL	REF NO : 9585-001-QOE-R-01 REVISION NO. 00 DATE: 26.04.2017

Sl. No.	ITEM	QP / INS CAT.	QP No:- 9585-001-QVE-	QP SUB. SCH.	QP APPL SCHE DULE	SUB-SUPPLIERS PROPOSED BY M/S L&T	PLACE	SUB- SUPPLIER APPL STATUS AS PER NTPC	SC APPL SCHED ULE	SC DETAIL SUB SCH	REMARKS
1.	HT Switchgear Panel up to 33KV with Vacuum type circuit breaker (BOIs preferably with VDE/CE/UL/CSA marked or BIS approved with valid CML no.)	I	Q-01			Siemens	Mumbai	A@			@- Subject to Sub-QR clearance from NTPC Engg.
						Megawin	Salem	A@			
						BHEL	Bhopal	A@			
						Jyoti	Vadodara	A@			
						ABB	Nasik	A@			
						L&T	Ahmednagar	A@			
						Schneider	Kolkata	A@			Upto 11KV -Salt lake works -Vg series Interrupter made at Salt Lake Works.
2.	Numerical Relay Network system Integration	I	Q-02			Main Contractor approved sources					@- Subject to Sub-QR clearance from NTPC Engg
3.	IEC 61850 Complaint Numerical Relays	(part of Swgr MQP				SEL	Pullman, USA	A@			@- Subject to Sub-QR clearance from NTPC Engg
						ALSTOM T&D	Stafford, UK	A@			P14X, P34X, P44X, P64X, P74X models only.

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(NTPC) (Bidder)

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एनटीपीसी NTPC	PROJECT: Patratu Super Thermal Power Station Expansion Phase-I (3x800MW) PACAKGE : EPC Sub Package : HT Switchgear dedicated Items CONTRACTOR : M/S BHEL CONT. NO.; CS-9585-001-02	LIST OF ITEMS REQUIRING QP APPROVAL & ACCEPTABLE VENDOR AS PROPOSED BY M/S BHEL	REF NO : 9585-001-QOE-R-01 REVISION NO. 00 DATE: 26.04.2017

Sl. No.	ITEM	QP / INS CAT.	QP No:- 9585-001- QVE-	QP SUB. SCH.	QP APPL SCHE DULE	SUB-SUPPLIERS PROPOSED BY M/S L&T	PLACE	SUB- SUPPLIER APPL STATUS AS PER NTPC	SC APPL SCHED ULE	SC DETAIL SUB SCH	REMARKS
						ALSTOM T&D	Chennai	A@			P14X, P24X, P34X, P44X, P64X, P74X models only.
						ABB	Finland	A@			
						ABB	Baroda	A@			For 6XX Series
						GE Multilin	Zamudio, Vizcaya, Spain/ Markham, Ontario, Canada	A@			F-650 only
						Schneider	Stone, UK	A@			PX30, PX40, VAMP 5X and VAMP 2XX models only.
						Siemens	Germany	A@			7SX Series only
						Siemens	Goa	A@			7SR2X series only
4.	MV Vacuum Contactor up to 6.6 KV	(part of Swgr MQP				ABB SACE	Italy	A			
						Jyoti	Vadodara	A			With Toshiba, Japan vacuum contactor bottle
						Megawin	Salem	A			For 6.6KV, 400A

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(NTPC) (Bidder)

C & M Dept. Patratu Vidyut Utpadan Nigam Limited * Distt-Ramgarh (Jharkhand) *

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एनटीपीसी NTPC	PROJECT: Patratu Super Thermal Power Station Expansion Phase-I (3x800MW) PACAKGE : EPC Sub Package : HT Switchgear dedicated Items CONTRACTOR : M/S BHEL CONT. NO.; CS-9585-001-02	LIST OF ITEMS REQUIRING QP APPROVAL & ACCEPTABLE VENDOR AS PROPOSED BY M/S BHEL	REF NO : 9585-001-QOE-R-01 REVISION NO. 00 DATE: 26.04.2017

Sl. No.	ITEM	QP / INS CAT.	QP No:- 9585-001-QVE-	QP SUB. SCH.	QP APPL SCHE DULE	SUB-SUPPLIERS PROPOSED BY M/S L&T	PLACE	SUB- SUPPLIER APPL STATUS AS PER NTPC	SC APPL SCHED ULE	SC DETAIL SUB SCH	REMARKS
											- With Toshiba Vacuum Bottle
						Siemens	Kalwa	DR			
5.	Fast Bus Transfer Panel	I	Q-03			Aartech	Parwanoo	A			FBT device Model-BTS-2000 from Cooper Power, USA
						ABB	Vadodara	A			FBT Device Model-SUE-3000 from ABB, Finland
						SEL	Delhi	A			FBT device Model-SEL-451 from SEL, USA
6.	FQP for HT switchgear	I	G-01								

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A Yadav
Amit Yadav
Mgr./MKTG.
BHEL.

Abbreviations

A – For these items proposed vendor is acceptable to NTPC. To be indicated with letter "A" in the list along with the condition of approval, if any.

DR – For these items "Detailed required" for NTPC review. To be identified with letter "DR" in the list.

QP/INSPECTION CATEGORY:

CAT-I : For these items the Quality Plans are approved by NTPC and the final acceptance will be on physical inspection witness by NTPC.

CAT-II : For these items the Quality Plans approved by NTPC. However no physical inspection shall be done by NTPC. The final acceptance by NTPC shall be on the basis review of documents as per approved QP.

CAT-III : For these items Main Supplier approves the Quality Plans. The final acceptance by NTPC shall be on the basis certificate of conformance by the main supplier.

General Notes:

1-Vendor list & category of the mandatory spares shall be as mentioned above.

2- For items not covered above, main contractor shall seek NTPC-QA's clearance before placing the order.

3- NTPC Approval conditions to above identified vendors shall be adhered to. Vendor's approval conditions will be informed on specific request of Main Contractor

4. Comprehensive L-2 list of sub-vendors shall be finalized with the finally selected L-1 vendor but prior to order finalization on L-1 vendor by the Bidder.

(NTPC)

(Bidder)

Patratu Vidyut Utpadan Nigam Limited ★ Distt-Ramgarh(Jharkhand) ★ C & M Deptt.

एनटीपीसी NTPC	PROJECT :PATRATU STPS (3X800 MW) PACAKGE : EPC Sub Package: MOTORS & VVF Drive Panels CONTRACTOR : M/S BHEL CONT. NO. CS-9585-001-2	LIST OF ITEMS REQUIRING QP APPROVAL & ACCEPTABLE VENDOR ; CONTRACTOR-M/S BHEL	REF NO : 9585-001-QOE-R-01 REVISION NO. 00 DATE 20th April 2017

Sl. No.	ITEM	QP / INS CAT.	QP No:- 9585-001-QVE-	QP SUB. SCH.	QP APPL SCHE DULE	SUB-SUPPLIERS	PLACE	SUB-SUPPLIER APPL. STATUS AS PER NTPC	SC APPL SCHE DULE	REMARKS
1)	L T (415 V) Motors	Refer Note 1				ABB	FARIDABAD	A		UPTO 55KW
						ABB	BANGALORE	A		55KW – 200KW
						BHARAT BIJLEE	MUMBAI	A		RQP, FOR FLAME PROOF ALSO
						CGL	AHMEDNAGAR	A		FOR FLAME PROOF ALSO
						JYOTI	BARODA	A		
						KEC	BANGALORE	A		FOR FLAMEVPROOF ALSO
						KEC	HUBLI	A		UPTO 90KW; FOR FLAME PROOF ALSO
						LHP	SOLAPUR	A		UPTO 200KW
						MARATHON	KOLKATA	A		FOR FLAME PROOF ALSO
						NGEF	BANGALORE	A		UPTO 15KW
						SIEMENS	MUMBAI	A		
2)	HT MOTOR	1				BHEL	BHOPAL	A		
3)	DC MOTOR	Refer Note 1				BHEL	HARIDWAR	A		
						CGL	AHMEDNAGAR	A		
						KEC	BANGLORE / HUBLI	DR		
4)	VARIABLE FREQUENCY DRIVES PANELS	1				L&T-YASHKAWA	INDIA	A		DR for HT
						DANFOSS	CHENNAI	A		
						SCHNEIDER	NASHIK	A		
						ROCKWELL ALLEN BRADLEY	DELHI-SHAHIBABAD	A		
						ABB	BANGALORE	A		
						SIEMENS	NASHIK	A		
						GE		DR		

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Patratu Vidyut Utpadan Nigam Limited ★ Distt-Ramgarh(Jharkhand) ★ C & M Deptt.

For BPC

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एनटीपीसी NTPC	PROJECT :PATRATU STPS (3X800 MW) PACAKGE : EPC Sub Package: MOTORS & VVF Drive Panels CONTRACTOR : M/S BHEL CONT. NO. CS-9585-001-2	LIST OF ITEMS REQUIRING QP APPROVAL & ACCEPTABLE VENDOR ; CONTRACTOR-M/S BHEL	REF NO : 9585-001-QOE-R-01 REVISION NO. 00 DATE 20th April 2017

Sl. No.	ITEM	QP / INS CAT.	QP No:- 9585-001-QVE-	QP SUB. SCH.	QP APPL SCHE DULE	SUB-SUPPLIERS	PLACE	SUB-SUPPLIER APPL. STATUS AS PER NTPC	SC APPL SCHE DULE	REMARKS
						HITACHI-HIREL	GANDHINAGAR/ SANAND	DR		
						INGETEAM TECHNOLOGIES	SPAIN	DR		
						NIDEC(ANSALDO)	ITALY	DR		
						FUJI ELECTRIC SYSTEMS	JAPAN	DR		
						TMEIC	BANGALORE	DR		
						L&T	MUMBAI	DR		

NOTE 1 : FOR LT MOTORS

a) Less than 30 KW

Acceptance of Motor less than 30 KW is based on COC of the manufacturer & the contractor confirming as follows:
It is hereby confirmed that the above mentioned motor /motors was/ were manufactured taking care of NTPC specific requirements regarding ambient temp., voltage & frequency variation, hot starts, pull out torque, starting KVA/KW, temp. rise, distance between centre of stud & gland plate and tested in accordance with approved drawing /data sheets.

b) 30 KW -50KW

Acceptance of Motor rating between 30 KW & 50 KW is based on NTPC review of Routine Test inspection report as per IS 325 witnessed by main contractor along with COC of the manufacturer & the contractor confirming as follows:
It is hereby confirmed that the above mentioned motor /motors was/ were manufactured taking care of NTPC specific requirements regarding ambient temp., voltage & frequency variation, hot starts, pull out torque, starting KVA/KW, temp. rise, distance between centre of stud & gland plate, space heater and tested in accordance with approved drawing /data sheets.

c) Above 50 KW as per NTPC approved quality plan

Approval Conditions attached to above vendors-as applicable shall prevail.

General Notes:

1) Vendor list & category of the mandatory spares shall be as mentioned above.
2) For item not appearing in the above list, main contractor to approach NTPC for acceptable vendors & inspection categorization of the same.
3) NTPC Approval conditions to above identified vendors shall be adhered to. Vendor's approval conditions will be informed on specific request of Main Contractor.

Bharat Heavy Electricals Limited PS-MKTG Delhi

JATIN GAHLAWAT, BHEL

Deptt.

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एनटीपीसी NTPC	PROJECT :PATRATU STPP (2X660 MW) PACAKGE : EPC Sub Package: HT Power cables, LT power cables, Control cables, CONTRACTOR : M/S BHEL CONT. NO. CS-9578-001-2	LIST OF ITEMS REQUIRING QP APPROVAL & ACCEPTABLE VENDOR AS PROPOSED BY M/S BHEL	REF NO : 9578-001-QOE-R-01 REVISION NO. 00 DATE 10th April 2017

Sl. No.	ITEM	QP / INS CAT.	QP No:- 9578-001-QVE-	QP SUB. SCH.	QP APPL SCHEDULE	SUB-SUPPLIERS PROPOSED BY M/S BHEL	PLACE	SUB-SUPPLIER APPL STATUS AS PER NTPC	SC APPL SCHEDULE	REMARKS
1	HT Cable upto 33KV	I	Q-01			Universal Cable Ltd.	Satna	A@		@- Subject to Sub-QR clearance from NTPC Engg
						Torrent Cable Ltd	Nadiad	A@		
						Polycab Wires Pvt. Ltd	Daman	A@		
						KEI Industries	Bhiwadi	A@		
						Havells India Ltd.	Alwar	A@		
						Finolex	Pune	A@		
						Apar	Valsad	A@		
						NICCO	Shamnagar , Kolkata	A@		Upto 11KV only
						Incab	Pune	A@		Upto 11KV only
						Sri ram Cables	Bhiwadi	A@		Upto 11KV only
						Krishna Electrical Indsutries Ltd	Gwalior	A@		Upto 11KV only
						KEC International	Vadodara	A@		
						Paramount	Bhiwadi	A@		
						Diamond Power	Vadodara	DR@		
						Crystal Cable	Kolkata	DR@		
						Gemscab	Bhiwadi	A@		
						CCI	Nasik	DR@		
						Tirupati Plastomatics	Jaipur	DR@		
						Dynamic Cables	Jaipur	DR@		
						Sterlite Technologies	Haridwar	DR@		
						Ravin Cables	Mumbai	DR@		
						Gupta Power	Bhubneshwar	DR@		
						GEMS CABLES	MEDAK ,TELANGA	DR@		
2	1.1 KV Power cable	I	Q-02			Universal Cable Ltd.	Satna	A@		@- Subject to Sub-QR clearance

Bharat Heavy Electricals Limited PS-MKTG Delhi

C & M 4/24/2017

एनटीपीसी NTPC	PROJECT :PATRATU STPP (2X660 MW) PACAKGE : EPC Sub Package: HT Power cables, LT power cables, Control cables, CONTRACTOR : M/S BHEL CONT. NO. CS-9578-001-2	LIST OF ITEMS REQUIRING QP APPROVAL & ACCEPTABLE VENDOR AS PROPOSED BY M/S BHEL	REF NO : 9578-001-QOE-R-01 REVISION NO. 00 DATE 10th April 2017

Sl. No.	ITEM	QP / INS CAT.	QP No:- 9578-001-QVE-	QP SUB. SCH.	QP APPL SCHEDULE	SUB-SUPPLIERS PROPOSED BY M/S BHEL	PLACE	SUB-SUPPLIER APPL STATUS AS PER NTPC	SC APPL SCHEDULE	REMARKS
	(PVC & XLPE)									from NTPC Engg
						NICCO	Shamnagar , Kolkata	A@		
						Torrent Cable Ltd	Nadiad	A@		
						Incab	Pune	A@		
						Hindustan Vidyut Products Ltd	Faridabad	A@		
						KEI Industries	Bhiwadi	A@		
						Delton Cable Ltd	Faridabad	A@		A)Unarmoured cable all sizes. B) Armoured cable up to 3.5 x 240 sq. Mm with GI strip armour and 1CX70 sq mm with al strip armour
						Paramount Cable	Khushkhera	A@		
						Polycab Wires Pvt. Ltd	Daman	A@		
						Gemscabs Industries	Bhiwadi	A@		
						Cords Cables	Bhiwadi	A@		
						Havells India Ltd.	Alwar	A@		
						Sri ram Cables	Bhiwadi	A@		
						Ravin Cables	Pune	A@		
						Thermocables	Hyderabad	A@		
						Sbee Cables	Bangalore	A@		
						Suyog Cables	Vadodara	A@		
						Gupta Power Cables	Bhubaneswar	A@		
						Finolex	Pune	A@		
						Scot Innovation wires & cables	Baddi	A@		
						Anhui Hualing	China	A@		
						LS Cable	Korea	A@		
						Radiant Cables	Hyderabad	A@		

Bharat Heavy Electricals Limited PS-MKTG Delhi

C & M Deptt.

एनटीपीसी NTPC	PROJECT :PATRATU STPP (2X660 MW) PACAKGE : EPC Sub Package: HT Power cables, LT power cables, Control cables, CONTRACTOR : M/S BHEL CONT. NO. CS-9578-001-2	LIST OF ITEMS REQUIRING QP APPROVAL & ACCEPTABLE VENDOR AS PROPOSED BY M/S BHEL	REF NO : 9578-001-QOE-R-01 REVISION NO. 00 DATE 10th April 2017

Sl. No.	ITEM	QP / INS CAT.	QP No:- 9578-001-QVE-	QP SUB. SCH.	QP APPL SCHEDULE	SUB-SUPPLIERS PROPOSED BY M/S BHEL	PLACE	SUB-SUPPLIER APPL STATUS AS PER NTPC	SC APPL SCHEDULE	REMARKS
						KEC International	Vadodara	DR@		
						Manisfield cables	G.Noida	DR@		
						Diamond Power	Vadodara	DR@		
						Crystal Cable	Kolkata	DR@		
						Apar Industries	Umbergaon	A@		
						Krishna Electricals	Gwalior	DR@		
						Special Cables	Rudrapur	A@		
						Dynamic Cables	Jaupiur	DR@		
						Tirupati Plastomatics	Jaipur	DR@		
						Govind Cables	Kolkata	DR@		
						Goyolene Fibre	Daman	DR@		
						Chandresh Cables	Gandhinagar	DR@		
3	1.1 KV Control cable	I	Q-03			NICCO	Shamnagar , Kolkata	A@		@- Subject to Sub-QR clearance from NTPC Engg
						Torrent Cable Ltd	Nadiad	A@		
						Incab	Pune	A@		
						Polycab WiresPvt. Ltd	Daman	A@		
						Hindustan Vidyut Products Ltd	Faridabad	A@		
						KEI Industries	Bhiwadi	A@		
						Delton Cable Ltd	Faridabad	A@		
						Paramount Cable	Khushkhera	A@		
						Gemscabs Industries	Bhiwadi	A@		
						Cords Cables	Bhiwadi	A@		
						SPM Cables	Hyderabad	A@		
						Elkay Telelink	Faridabad	A@		
						Havells India Ltd.	Alwar	A@		

Bharat Heavy Electricals Limited ★ PS-MKTG Delhi

C & M Deptt. 4/24/2017

एनटीपीसी NTPC	PROJECT :PATRATU STPP (2X660 MW) PACAKGE : EPC Sub Package: HT Power cables, LT power cables, Control cables, CONTRACTOR : M/S BHEL CONT. NO. CS-9578-001-2	LIST OF ITEMS REQUIRING QP APPROVAL & ACCEPTABLE VENDOR AS PROPOSED BY M/S BHEL	REF NO : 9578-001-QOE-R-01 REVISION NO. 00 DATE 10th April 2017

Sl. No.	ITEM	QP / INS CAT.	QP No:- 9578-001-QVE-	QP SUB. SCH.	QP APPL SCHEDULE	SUB-SUPPLIERS PROPOSED BY M/S BHEL	PLACE	SUB-SUPPLIER APPL STATUS AS PER NTPC	SC APPL SCHEDULE	REMARKS
						R.R. Kabel	Silvasa	A@		
						Ravin Cables	Pune	A@		
						Gupta Power cable	Bhubaneswar	A@		
						Thermocables	Hyderabad	A@		
						Finolex	Pune	A@		
						Sbee Cables	Bangalore	A@		
						Suyog Cables	Vadodara	A@		
						Universal Cables	Satna	A@		
						Scot Innovation wires & cables	Baddi	A@		
						Anhui Hualing	China	A@		
						LS Cable	Korea	A@		
						Radiant Cables	Hyderabad	A@		
						KEC International	Vadodara	DR@		Out of the identified "DR"vendors , BHEL shall propose maximum 5 no. of vendors for NTPC review
						Manisfield cables	G.Noida	DR@		
						Diamond Power	Vadodara	DR@		
						Crystal Cable	Kolkata	DR@		
						Apar Industries	Vadodara	DR@		
						Krishna Electricals	Gwalior	DR@		
						Special Cables	Rudrapur	A@		
						Govind Cables	Kolkata	DR@		
						Incom	Delhi	DR@		
						Sam Cables	Rudrapur	DR@		
						Advance Cables	Bangalore	DR@		
						Tirupati Plastomatics	JAipur	DR@		
						CMI	Faridabad	A@		
						Sarval India	Nimrana	DR@		
						Advance Cable	BAngalore	DR@		
						Goyolene Fibre	Daman	DR@		
						Sriram Cables Dynamic Cables	Alwar Jaipur	DR@ DR@		

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Rajasthan Rajya Vidyut Utpadan Nigam Limited C & M Deptt. Kota

NTPC 4 OF 5 ENGINEERING DIV / QAI CONTRACTOR 4/24/2017

एनटीपीसी NTPC	PROJECT :PATRATU STPP (2X660 MW) PACAKGE : EPC Sub Package: HT Power cables, LT power cables, Control cables, CONTRACTOR : M/S BHEL CONT. NO. CS-9578-001-2	LIST OF ITEMS REQUIRING QP APPROVAL & ACCEPTABLE VENDOR AS PROPOSED BY M/S BHEL	REF NO : 9578-001-QOE-R-01 REVISION NO. 00 DATE 10th April 2017

Sl. No.	ITEM	QP / INS CAT.	QP No:- 9578-001- QVE-	QP SUB. SCH.	QP APPL SCHEDULE	SUB-SUPPLIERS PROPOSED BY M/S BHEL	PLACE	SUB-SUPPLIER APPL STATUS AS PER NTPC	SC APPL SCHEDULE	REMARKS
4	FQP of Cables & Accessories	I	G-01							SFQP no. -000-999-QOE-I-004 will be applicable

Note 1 : Approval conditions attached to sub- vendors shall be adhered to.

Note 2 : Abbreviations

A – For these items proposed vendor is acceptable to NTPC. To be indicated with letter "A" in the list alongwith the condition of approval, if any.

DR – For these items "Detailed required" for NTPC review. To be identified with letter "DR" in the list.

NOTED – For these items vendors are approved by Main Supplier and accepted by NTPC without specific vendor approval from NTPC. To be identified with "NOTED.'

1. QP/INSPN CATEGORY:

CAT-I : For these items the Quality Plans are approved by NTPC and the final acceptance will be on physical inspection witness by NTPC.

CAT-II : For these items the Quality Plans approved by NTPC. However no physical inspection shall be done by NTPC. The final acceptance by NTPC shall be on the basis review of documents as per approved QP.

CAT-III : For these items Main Supplier approves the Quality Plans.The final acceptance by NTPC shall be on the basis certificate of conformance by the main supplier.

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LT SWITCHGEAR panels' sub-vendors are subject to sub-QR clearance from NTPC-Engg

एनटीपीसी NTPC	PROJECT : PATRATU STPP, PACAKGE : Sub Package: LT Switchgear & LT Busduct CONTRACTOR : M/S BHEL CONT. NO. CS- --- -001C-2	LIST OF ITEMS REQUIRING QP APPROVAL & ACCEPTABLE VENDOR AS PROPOSED BY M/S BHEL
		REF NO : ----001-QOE-R-01 REVISION NO. 00 DATE -

Sl. No.	ITEM	QP / INS CAT.	QP No:- 9591-001- QVE-	QP SUB. SCH.	QP APPL SCHE DULE	SUB-SUPPLIERS PROPOSED BY M/S BHEL	PLACE	SUB-SUPPLIER APPL STATUS AS PER NTPC	SC APPL SCHE DULE	REMARKS
										pg. 1
1	Floor mounted Draw out type indoor LT Switchgear Panel (MCC panels etc.)	I	I			L&T	Mumbai / Coimbatore/ Ahmednagar	A@		@- Subject to Sub-QR clearance from NTPC Engg. BOIs preferably with VDE/CE/UL/CSA marked or BIS approved with valid CML no.
						GE	Bangalore	A@		@- Subject to Sub-QR clearance from NTPC Engg BOIs preferably with VDE/CE/UL/CSA marked or BIS approved with valid CML no.
						Siemens	Mumbai	A@		@- Subject to Sub-QR clearance from NTPC Engg. BOIs preferably with VDE/CE/UL/CSA marked or BIS approved with valid CML no.
						C&S Electric	Noida /	A@		@- Subject to Sub-QR clearance from

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LT SWITCHGEAR panels' sub-vendors are subject to sub-QR clearance from NTPC-Engg

एनटीपीसी NTPC	PROJECT : PATRATU STPP, PACAKGE : Sub Package: LT Switchgear & LT Busduct CONTRACTOR : M/S BHEL CONT. NO. CS- --- -001C-2	LIST OF ITEMS REQUIRING QP APPROVAL & ACCEPTABLE VENDOR AS PROPOSED BY M/S BHEL	REF NO : -----001-QOE-R-01 REVISION NO. 00 DATE -

Sl. No.	ITEM	QP / INS CAT.	QP No:- 9591-001-QVE-	QP SUB. SCH.	QP APPL SCHE DULE	SUB-SUPPLIERS PROPOSED BY M/S BHEL	PLACE	SUB-SUPPLIER APPL STATUS AS PER NTPC	SC APPL SCHE DULE	REMARKS
										pg. 2
							Hardwar			NTPC Engg. BOIs preferably with VDE/CE/UL/CSA marked or BIS approved with valid CML no.
						Schneider	Nasik	A@		ACB from Schneider, France. @- Subject to Sub-QR clearance from NTPC Engg. BOIs preferably with VDE/CE/UL/CSA marked or BIS approved with valid CML no.
						Unilec	Gurgaon	A@		@- Subject to Sub-QR clearance from NTPC Engg. BOIs preferably with VDE/CE/UL/CSA marked or BIS approved with valid CML no.
						ABB	Bangalore	DR@		@- Subject to Sub-QR clearance from NTPC Engg.

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LT SWITCHGEAR panels' sub-vendors are subject to sub-QR clearance from NTPC-Engg

एनटीपीसी NTPC	PROJECT : PATRATU STPP, PACAKGE : Sub Package: LT Switchgear & LT Busduct CONTRACTOR : M/S BHEL CONT. NO. CS- --- -001C-2					LIST OF ITEMS REQUIRING QP APPROVAL & ACCEPTABLE VENDOR AS PROPOSED BY M/S BHEL				REF NO : -----001-QOE-R-01 REVISION NO. 00 DATE -
Sl. No.	ITEM	QP / INS CAT.	QP No:- 9591-001- QVE-	QP SUB. SCH.	QP APPL SCHE DULE	SUB-SUPPLIERS PROPOSED BY M/S BHEL	PLACE	SUB-SUPPLIER APPL STATUS AS PER NTPC	SC APPL SCHE DULE	REMARKS pg. 3
2.	Floor mounted Fixed type indoor LT Switchgear Panel (ACDB / DCDB / Lighting DB / Solenoid valve distribution boards) (subject to sub-QR)	1	2			L&T	Mumbai / Coimbatore/ Ahmednagar	A*		*- DR for Fixed type outdoor LT Switchgear Panel BOIs preferably with VDE/CE/UL/CSA marked or BIS approved with valid CML no.
						GE	Bangalore	A*		*- DR for Fixed type outdoor LT Switchgear Panel BOIs preferably with VDE/CE/UL/CSA marked or BIS approved with valid CML no.
						Siemens	Mumbai	A*		*- DR for Fixed type outdoor LT

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LT SWITCHGEAR panels' sub-vendors are subject to sub-QR clearance from NTPC-Engg

एनटीपीसी NTPC	PROJECT : PATRATU STPP, PACAKGE : Sub Package: LT Switchgear & LT Busduct CONTRACTOR : M/S BHEL CONT. NO. CS- --- -001C-2	LIST OF ITEMS REQUIRING QP APPROVAL & ACCEPTABLE VENDOR AS PROPOSED BY M/S BHEL

REF NO : -----001-QOE-R-01
REVISION NO. 00

DATE -

Sl. No.	ITEM	QP / INS CAT.	QP No:- 9591-001-QVE-	QP SUB. SCH.	QP APPL SCHE DULE	SUB-SUPPLIERS PROPOSED BY M/S BHEL	PLACE	SUB-SUPPLIER APPL STATUS AS PER NTPC	SC APPL SCHE DULE	REMARKS
										pg. 4
										Switchgear Panel BOIs preferably with VDE/CE/UL/CSA marked or BIS approved with valid CML no.
						C&S Electric	Noida / Hardwar	A*		*- DR for Fixed type outdoor LT Switchgear Panel BOIs preferably with VDE/CE/UL/CSA marked or BIS approved with valid CML no.
						Schneider	Nasik	A*		*- DR for Fixed type outdoor LT Switchgear Panel BOIs preferably with VDE/CE/UL/CSA marked or BIS approved with valid CML no.
						Unilec	Gurgaon	A*		*- DR for Fixed type outdoor LT Switchgear Panel BOIs preferably with VDE/CE/UL/CSA marked or BIS approved with valid CML no.
						Switching Circuits	Kolkata	A*		*- DR for Fixed type outdoor LT

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LT SWITCHGEAR panels' sub-vendors are subject to sub-QR clearance from NTPC-Engg

एनटीपीसी NTPC	PROJECT : PATRATU STPP, PACAKGE : Sub Package: LT Switchgear & LT Busduct CONTRACTOR : M/S BHEL CONT. NO. CS- --- -001C-2	LIST OF ITEMS REQUIRING QP APPROVAL & ACCEPTABLE VENDOR AS PROPOSED BY M/S BHEL	REF NO : ----001-QOE-R-01 REVISION NO. 00 DATE -

Sl. No.	ITEM	QP / INS CAT.	QP No:- 9591-001-QVE-	QP SUB. SCH.	QP APPL SCHE DULE	SUB-SUPPLIERS PROPOSED BY M/S BHEL	PLACE	SUB-SUPPLIER APPL STATUS AS PER NTPC	SC APPL SCHE DULE	REMARKS
										pg. 5
										Switchgear Panel BOIs preferably with VDE/CE/UL/CSA marked or BIS approved with valid CML no.
						Tricolite	Sahibabad / Manesar	A*		*- DR for Fixed type outdoor LT Switchgear Panel BOIs preferably with VDE/CE/UL/CSA marked or BIS approved with valid CML no.
						Hindustan Control & equipment Ltd	Kolkata	A*		With fabrication & painting at unit II & MP Electrical Narendrapur *- DR for Fixed type outdoor LT Switchgear Panel BOIs preferably with VDE/CE/UL/CSA marked or BIS approved with valid CML no.
						Maktel	Vadodara	A*		*- DR for Fixed type outdoor LT Switchgear Panel BOIs preferably with VDE/CE/UL/CSA marked or BIS approved with valid

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LT SWITCHGEAR panels' sub-vendors are subject to sub-QR clearance from NTPC-Engg

एनटीपीसी NTPC	PROJECT : PATRATU STPP, PACAKGE : Sub Package: LT Switchgear & LT Busduct CONTRACTOR : M/S BHEL CONT. NO. CS- --- -001C-2	LIST OF ITEMS REQUIRING QP APPROVAL & ACCEPTABLE VENDOR AS PROPOSED BY M/S BHEL	REF NO : -----001-QOE-R-01 REVISION NO. 00 DATE -

Sl. No.	ITEM	QP / INS CAT.	QP No:- 9591-001-QVE-	QP SUB. SCH.	QP APPL SCHE DULE	SUB-SUPPLIERS PROPOSED BY M/S BHEL	PLACE	SUB-SUPPLIER APPL STATUS AS PER NTPC	SC APPL SCHE DULE	REMARKS
										pg. 6
										CML no.
						Jakson	Greater Noida	A*		*- DR for Fixed type outdoor LT Switchgear Panel BOIs preferably with VDE/CE/UL/CSA marked or BIS approved with valid CML no.
						Vidyut Control	Gaziabad	A*		*- DR for Fixed type outdoor LT Switchgear Panel BOIs preferably with VDE/CE/UL/CSA marked or BIS approved with valid CML no.
						Adlec Power	Rohad (Jhajjar)	A*		*- DR for Fixed type outdoor LT Switchgear Panel BOIs preferably with VDE/CE/UL/CSA marked or BIS approved with valid CML no.
						Pyrotech	Udaipur	A*		*- DR for Fixed type outdoor LT Switchgear Panel BOIs preferably with VDE/CE/UL/CSA marked or BIS approved with valid CML no.

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LT SWITCHGEAR panels' sub-vendors are subject to sub-QR clearance from NTPC-Engg

एनटीपीसी NTPC	PROJECT : PATRATU STPP, PACAKGE : Sub Package: LT Switchgear & LT Busduct CONTRACTOR : M/S BHEL CONT. NO. CS- --- -001C-2	LIST OF ITEMS REQUIRING QP APPROVAL & ACCEPTABLE VENDOR AS PROPOSED BY M/S BHEL	REF NO : -----001-QOE-R-01 REVISION NO. 00 DATE -

Sl. No.	ITEM	QP / INS CAT.	QP No:- 9591-001-QVE-	QP SUB. SCH.	QP APPL SCHE DULE	SUB-SUPPLIERS PROPOSED BY M/S BHEL	PLACE	SUB-SUPPLIER APPL STATUS AS PER NTPC	SC APPL SCHE DULE	REMARKS
										pg. 7
						Anand Power Ltd.	Noida	A*		*- DR for Fixed type outdoor LT Switchgear Panel BOIs preferably with VDE/CE/UL/CSA marked or BIS approved with valid CML no.
						Control & Schematics	Hyderabad	A*		*- DR for Fixed type outdoor LT Switchgear Panel BOIs preferably with VDE/CE/UL/CSA marked or BIS approved with valid CML no.
						Positronics	Vadodara	A*		*- DR for Fixed type outdoor LT Switchgear Panel BOIs preferably with VDE/CE/UL/CSA marked or BIS approved with valid CML no.
						ABB	Bangalore	DR		
						Nitya Electrocontrols	Noida	A*		*- DR for Fixed type outdoor LT Switchgear Panel BOIs preferably with VDE/CE/UL/CSA marked or BIS approved with valid

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LT SWITCHGEAR panels' sub-vendors are subject to sub-QR clearance from NTPC-Engg

एनटीपीसी NTPC	PROJECT : PATRATU STPP, PACAKGE : Sub Package: LT Switchgear & LT Busduct CONTRACTOR : M/S BHEL CONT. NO. CS- --- -001C-2	LIST OF ITEMS REQUIRING QP APPROVAL & ACCEPTABLE VENDOR AS PROPOSED BY M/S BHEL	REF NO : -----001-QOE-R-01 REVISION NO. 00 DATE -

Sl. No.	ITEM	QP / INS CAT.	QP No:- 9591-001-QVE-	QP SUB. SCH.	QP APPL SCHE DULE	SUB-SUPPLIERS PROPOSED BY M/S BHEL	PLACE	SUB-SUPPLIER APPL STATUS AS PER NTPC	SC APPL SCHE DULE	REMARKS
										pg. 8
										CML no.
3	Wall mounted fixed type indoor / outdoor LT Switchgear non compartmentalized Panel (Lighting panels / AC / DC Fuse boards / MCB boxes)	I	3			L&T	Mumbai / Coimbatore/ Ahmednagar	A		BOIs preferably with CE/VDE/UL/CSA marked or BIS approved with valid CML no.
						GE	Bangalore	A		BOIs preferably with CE/VDE/UL/CSA marked or BIS approved with valid CML no.
						Siemens	Mumbai	A		BOIs preferably with CE/VDE/UL/CSA marked or BIS approved with valid CML no.
						C&S Electric	Noida / Hardwar	A		BOIs preferably with CE/VDE/UL/CSA marked or BIS approved with valid CML no.
						Schneider	Nasik	A		BOIs preferably with CE/VDE/UL/CSA

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LT SWITCHGEAR panels' sub-vendors are subject to sub-QR clearance from NTPC-Engg

एनटीपीसी NTPC	PROJECT : PATRATU STPP, PACAKGE : Sub Package: LT Switchgear & LT Busduct CONTRACTOR : M/S BHEL CONT. NO. CS- --- -001C-2	LIST OF ITEMS REQUIRING QP APPROVAL & ACCEPTABLE VENDOR AS PROPOSED BY M/S BHEL	REF NO : -----001-QOE-R-01 REVISION NO. 00 DATE -

Sl. No.	ITEM	QP / INS CAT.	QP No:- 9591-001-QVE-	QP SUB. SCH.	QP APPL SCHE DULE	SUB-SUPPLIERS PROPOSED BY M/S BHEL	PLACE	SUB-SUPPLIER APPL STATUS AS PER NTPC	SC APPL SCHE DULE	REMARKS
										pg. 9
										marked or BIS approved with valid CML no.
						Unilec	Gurgaon	A		BOIs preferably with CE/VDE/UL/CSA marked or BIS approved with valid CML no.
						Switching Circuits	Kolkata	A		BOIs preferably with CE/VDE/UL/CSA marked or BIS approved with valid CML no.
						Tricolite	Sahibabad / Manesar	A		BOIs preferably with CE/VDE/UL/CSA marked or BIS approved with valid CML no.
						Hindustan Control & equipment Ltd	Kolkata	A		With fabrication & painting at unit II & MP Electrical Narendrapur BOIs preferably with CE/VDE/UL/CSA marked or BIS approved with valid CML no.
						Maktel	Vadodara	A		BOIs preferably with CE/VDE/UL/CSA marked or BIS approved with valid CML no.
						Jakson	Greater Noida	A		BOIs preferably with CE/VDE/UL/CSA marked or BIS approved with valid CML no.
						Vidyut Control	Gaziabad	A		BOIs preferably with CE/VDE/UL/CSA marked or BIS approved with valid

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LT SWITCHGEAR panels' sub-vendors are subject to sub-QR clearance from NTPC-Engg

एनटीपीसी NTPC	PROJECT : PATRATU STPP, PACAKGE : Sub Package: LT Switchgear & LT Busduct CONTRACTOR : M/S BHEL CONT. NO. CS- --- -001C-2	LIST OF ITEMS REQUIRING QP APPROVAL & ACCEPTABLE VENDOR AS PROPOSED BY M/S BHEL	REF NO : -----001-QOE-R-01 REVISION NO. 00 DATE -

Sl. No.	ITEM	QP / INS CAT.	QP No:- 9591-001-QVE-	QP SUB. SCH.	QP APPL SCHE DULE	SUB-SUPPLIERS PROPOSED BY M/S BHEL	PLACE	SUB-SUPPLIER APPL STATUS AS PER NTPC	SC APPL SCHE DULE	REMARKS
										pg. 10
										CML no.
						Adlec Power	Rohad (Jhajjar)	A		BOIs preferably with CE/VDE/UL/CSA marked or BIS approved with valid CML no.
						Pyrotech	Udaipur	A		BOIs preferably with CE/VDE/UL/CSA marked or BIS approved with valid CML no.
						Anand Power Ltd.	Noida	A		BOIs preferably with CE/VDE/UL/CSA marked or BIS approved with valid CML no.
						Control & Schematics	Hyderabad	A		BOIs preferably with CE/VDE/UL/CSA marked or BIS approved with valid CML no.
						Positronics	Vadodara	A		BOIs preferably with CE/VDE/UL/CSA marked or BIS approved with valid CML no.
						Control Devices	Kolkata	A		BOIs preferably with CE/VDE/UL/CSA marked or BIS approved with valid CML no.
						Jasper	Noida	A		BOIs preferably with CE/VDE/UL/CSA marked or BIS approved with valid CML no.
						Havells	Faridabad	A		BOIs preferably with CE/VDE/UL/CSA marked or BIS approved with valid

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LT SWITCHGEAR panels' sub-vendors are subject to sub-QR clearance from NTPC-Engg

एनटीपीसी NTPC	PROJECT : PATRATU STPP, PACAKGE : Sub Package: LT Switchgear & LT Busduct CONTRACTOR : M/S BHEL CONT. NO. CS- --- -001C-2	LIST OF ITEMS REQUIRING QP APPROVAL & ACCEPTABLE VENDOR AS PROPOSED BY M/S BHEL	REF NO : -----001-QOE-R-01 REVISION NO. 00 DATE -

Sl. No.	ITEM	QP / INS CAT.	QP No:- 9591-001-QVE-	QP SUB. SCH.	QP APPL SCHE DULE	SUB-SUPPLIERS PROPOSED BY M/S BHEL	PLACE	SUB-SUPPLIER APPL STATUS AS PER NTPC	SC APPL SCHE DULE	REMARKS
										pg. 11
										CML no.
						Novateur Electrical & distribution systems	Murthal	A		BOIs preferably with CE/VDE/UL/CSA marked or BIS approved with valid CML no.
						Avaid Technovator	Manesar	A		BOIs preferably with CE/VDE/UL/CSA marked or BIS approved with valid CML no.
4	ACB	(part of LT Swgr MQP)	4			C&S Electric	Noida	A		
						L&T	Mumbai	A		
						GE	Bangalore	A		
						Siemens	Germany	A		
						Schneider	France	A		
5	LT Busduct (air insulated non phase segregated type)	1	5			C&S Electric	G.Noida	A		
						C&S Electric	Hardwar	A		
						Unilec	Gurgaon	A		Upto 3200 A
						KGS Engg Ltd	Chennai	A		
						Spaceage Swgr Ltd	Bawal	A		
						REEP	Chennai	A		
						Enpro	Chennai	A		
						Jasper Engg Ltd	Noida	A		

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LT SWITCHGEAR panels' sub-vendors are subject to sub-QR clearance from NTPC-Engg

एनटीपीसी NTPC	PROJECT : PATRATU STPP, PACAKGE : Sub Package: LT Switchgear & LT Busduct CONTRACTOR : M/S BHEL CONT. NO. CS- --- -001C-2	LIST OF ITEMS REQUIRING QP APPROVAL & ACCEPTABLE VENDOR AS PROPOSED BY M/S BHEL	REF NO : -----001-QOE-R-01 REVISION NO. 00 DATE -

Sl. No.	ITEM	QP / INS CAT.	QP No:- 9591-001-QVE-	QP SUB. SCH.	QP APPL SCHE DULE	SUB-SUPPLIERS PROPOSED BY M/S BHEL	PLACE	SUB-SUPPLIER APPL. STATUS AS PER NTPC	SC APPL SCHE DULE	REMARKS
										pg. 12
6	LT Buct (insulated sandwitched type)	1	6			C&S Electric	Hardwar	A		
						Jasper Engg Ltd	Noida	DR		
						Schneider	Baroda	DR		
						Henikwon	Malaysia	A		
7	IEC 61850 Compliant Numerical Relays	(part of Swgr MQP)				SEL	Pullman, USA	A@		A@- Subject to Sub-QR clearance form NTPC Engg
						ALSTOM T&D	Stafford, UK	A@		P14X, P34X, P44X, P64X, P74X models only. A@- Subject to Sub-QR clearance form NTPC Engg
						ALSTOM T&D	Chennai	A@		P14X, P34X, P44X, P64X, P74X models only. A@- Subject to Sub-QR clearance form NTPC Engg
						GE Multilin	Zamudio, Vizcaya, Spain/ Markham, Ontario, Canada	A@		F 650 only A@- Subject to Sub-QR clearance form NTPC Engg

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LT SWITCHGEAR panels' sub-vendors are subject to sub-QR clearance from NTPC-Engg

एनटीपीसी NTPC	PROJECT : PATRATU STPP, PACAKGE : Sub Package: LT Switchgear & LT Busduct CONTRACTOR : M/S BHEL CONT. NO. CS- --- -001C-2	LIST OF ITEMS REQUIRING QP APPROVAL & ACCEPTABLE VENDOR AS PROPOSED BY M/S BHEL	REF NO : -----001-QOE-R-01 REVISION NO. 00 DATE -

Sl. No.	ITEM	QP / INS CAT.	QP No:- 9591-001- QVE-	QP SUB. SCH.	QP APPL SCHE DULE	SUB-SUPPLIERS PROPOSED BY M/S BHEL	PLACE	SUB-SUPPLIER APPL STATUS AS PER NTPC	SC APPL SCHE DULE	REMARKS
						Schneider	Stone, UK	A@		PX30 & PX40 models only. A@- Subject to Sub-QR clearance form NTPC Engg
						ABB	Finland	A@		A@- Subject to Sub-QR clearance form NTPC Engg
						ABB	Baroda	A@		For 6XX Series A@- Subject to Sub-QR clearance form NTPC Engg
						Siemens	Goa	A@		7SR2X series only A@- Subject to Sub-QR clearance form NTPC Engg
						Siemens	Germany	A@		7SX Series only A@- Subject to Sub-QR clearance form NTPC Engg
8	Local Push Button Station	III				Main contractor approved sources for the box (with push button with CE/VDE/UL/CSA marked or BIS approved with valid CML no.)		Noted		
9	FQP for LT	I	G-01							

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LT SWITCHGEAR panels' sub-vendors are subject to sub-QR clearance from NTPC-Engg

एनटीपीसी NTPC	PROJECT : PATRATU STPP, PACAKGE : Sub Package: LT Switchgear & LT Busduct CONTRACTOR : M/S BHEL CONT. NO. CS- ---- -001C-2	LIST OF ITEMS REQUIRING QP APPROVAL & ACCEPTABLE VENDOR AS PROPOSED BY M/S BHEL	REF NO : ----001-QOE-R-01 REVISION NO. 00 DATE -

Sl. No.	ITEM	QP / INS CAT.	QP No:- 9591-001-QVE-	QP SUB. SCH.	QP APPL SCHE DULE	SUB-SUPPLIERS PROPOSED BY M/S BHEL	PLACE	SUB-SUPPLIER APPL. STATUS AS PER NTPC	SC APPL SCHE DULE	REMARKS
	Switchgear									pg. 14
10	FQP for LT Busduct	I	G-02							

NB:
Under Sub Supplier approval status as per NTPC column:
A: mean that vendor for this item is acceptable to NTPC.
Under QP / INSPN CATEGORY column:
CAT-I : For these items the Quality Plans approved by NTPC & final acceptance will be on physical inspection & witness by NTPC
CAT-II : For these items the Quality Plans approved by NTPC. However no physical inspection shall be done by NTPC. The final acceptance by NTPC shall be on basis of verification of documents as per approved QP
CAT-III : For these items Main supplier approves the Quality Plans. The final acceptance by NTPC shall be on basis of certificate of conformance by the main supplier.
General Notes:
Vendor list & category of the mandatory spares shall be as mentioned above.
For item not appearing in the above list, main contractor to approach NTPC for acceptable vendors & inspection categorization of the same.
NTPC Approval conditions to above identified vendors shall be adhered to. Vendor's approval conditions will be informed on specific request of Main Contractor.

Note-1- VDE / CE / UL / CSA MARKING CERTIFICATION PREFERABLY FROM THIRD PARTY AGENCY OR BIS APPROVAL LETTER SHALL BE SUBMITTED FOR NTPC's VERIFICATION /INFORMATION

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Patratu Vidyut Utpadan Nigam Limited C & M Deptt.

Yadav, Amit Yadav Manager / PS-MKTG. BHEL

LT SWITCHGEAR panels' sub-vendors are subject to sub-QR clearance from NTPC-Engg

एनटीपीसी NTPC	PROJECT : PATRATU STPP, PACAKGE : Sub Package: LT Switchgear & LT Busduct CONTRACTOR : M/S BHEL CONT. NO. CS- ---- -001C-2	LIST OF ITEMS REQUIRING QP APPROVAL & ACCEPTABLE VENDOR AS PROPOSED BY M/S BHEL	REF NO : -----001-QOE-R-01 REVISION NO. 00 DATE -

Sl. No.	ITEM	QP / INS CAT.	QP No:- 9591-001- QVE-	QP SUB. SCH.	QP APPL SCHE DULE	SUB-SUPPLIERS PROPOSED BY M/S BHEL	PLACE	SUB-SUPPLIER APPL STATUS AS PER NTPC	SC APPL SCHE DULE	REMARKS

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★ Patratu Vidyut Utpadan Nigam Limited ★ Distt-Ramgarh(Jharkhand) C & M Deptt.

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एनटीपीसी NTPC	PROJECT :Patratu STPP (2X660 MW) PACAKGE :EPC Sub Package: Electrical Equipment Supply & Erection CONTRACTOR : M/S BHEL CONT. NO. CS-9585-001-2	LIST OF ITEMS REQUIRING QP APPROVAL & ACCEPTABLE VENDOR Contractor-M/S BHEL	REF NO : 9585-001-QOE-R-01 REVISION NO. 00 DATE 24th April 2017

Sl. No.	ITEM	QP / INS CAT.	QP No:- 9578-001-QVE-	QP SUB. SCH.	QP APPL SCHEDULE	SUB-SUPPLIERS	PLACE	SUB-SUPPLIER APPL STATUS AS PER NTPC	SC APPL SCHEDULE	REMARKS
1.	Alternator	I	1			M/s Kirloskar Electric	Bangalore	A		415 V alternators
						M/s Cummins Generator Technology (Stamford)	U.K	A		415 V & 11kV alternators
						M/s Leroy Somer	France	A		Up to 11kV alternator 3500 kW
						M/s Marathan	USA	A		Alternators for up to 415 V, 1500 KVA DG SET
						M/s Cummins Generator Technology (Stamford)	Ahmednagar	A		415 V Alternators up to 1600 KVA
						Toshiba	Chennai	DR		
2.	Diesel engine	I	2			M/s Cummins	Pune	A		
						M/s Cater Pillar	USA	A		
						M/s Mitsubishi	Japan	A		Diesel engine for up to 1500 KVA DG SET
						M/s MTU	Germany	A		Diesel engine for up to 1500 KVA DG SET
						M/s Perkins	UK	A		Diesel Engine for upto 2000KVA DG SET
3.	D G set (assembly testing) @ subject to sub-QR clearance	I	3			M/s TIL	Ghaziabad	A@		up to 1500 KVA
						M/s. Kohler	Singapore	A@		Up to 1500 kVA ,11kV
						M/s CLLS	Singapore	A@		Up to 1250 kVA, 415 V,
						M/s Powerica	Silvasa	A@		Up to 2000 KVA, 415 V & 1500 KVA, 11 KV
						M/s Jakson	Kathua	A@		Up to 415 V, 2000 KVA
						M/s Sterling Generators Pvt Ltd	Silvasa	A@		For up to 415 V 1500 KVA
						M/s Supernova	Rajpur	A@		
4.	DG Set acoustic enclosure	II				DG Set supplier approved sources		Noted		

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C & M Deptt. Patratu Vidyut Utpadan Nigam Limited Ramgarh (Jharkhand)

एनटीपीसी NTPC	PROJECT :Patratu STPP (2X660 MW) PACAKGE :EPC Sub Package: Electrical Equipment Supply & Erection CONTRACTOR : M/S BHEL CONT. NO. CS-9585-001-2	LIST OF ITEMS REQUIRING QP APPROVAL & ACCEPTABLE VENDOR Contractor-M/S BHEL	REF NO : 9585-001-QOE-R-01 REVISION NO. 00 DATE 24th April 2017

Sl. No.	ITEM	QP / INS CAT.	QP No:- 9578-001-QVE-	QP SUB. SCH.	QP APPL SCHEDULE	SUB-SUPPLIERS	PLACE	SUB-SUPPLIER APPL STATUS AS PER NTPC	SCAPPL SCHEDULE	REMARKS
5.	Battery charger (110V/220V) @ subject to sub-QR clearance	1	4			M/s Amararaja	Tirupati	A@		
						M/s HBL- Power System	Hyderabad	A@		
						M/s Chhabi electrical	Jalgaon	A@		
						M/s. Chloride Power	Kolkatta	A@		
						M/s Statcon	Hapur	A@		Approved Up to 220, V 850 A subject to Sub-QR clearance, higher rating in DR
						M/s Dubas	Bangalore	A@		Approved upto 220 V, 850 A subject to Sub-QR clearance , higher rating in DR
						M/s Saft Nife Power Systems	Singapore	A@		
						Massteck	Jalgaon	A@		
						Emerson Network	Thane	DR@		
						Jema Energy	Spain	DR@		
6.	Battery (Ni-Cd)	1	5			M/S HBL-Power System	Hyderabad	A @		Up to 990 Ah with conditions(Pocket plate type)
						M/S Amcosaft	Bangalore	A @		8Ah to 990Ah- KPH type 10Ah to 1365 Ah- KPM type 11Ah to 1550Ah – KPL type (Pocket plate type)
						Hoppekke	Germany	A@		
						Exide	Kolkata	DR@		
7.	Battery Plante	1	6			M/s Exide	Kolkata	A@		
						Hoppekke	Germany	DR@		

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Patratu Vidyut Utpadan Nigam Limited ★ Dist-Ramgarh(Jharkhand) ★ C & M Deptt.

एनटीपीसी NTPC	PROJECT :Patratu STPP (2X660 MW) PACAKGE :EPC Sub Package: Electrical Equipment Supply & Erection CONTRACTOR : M/S BHEL CONT. NO. CS-9585-001-2	LIST OF ITEMS REQUIRING QP APPROVAL & ACCEPTABLE VENDOR Contractor-M/S BHEL	REF NO : 9585-001-QOE-R-01 REVISION NO. 00 DATE 24th April 2017

SL No.	ITEM	QP / INS CAT.	QP No:- 9578-001-QVE-	QP SUB. SCH.	QP APPL SCHEDULE	SUB-SUPPLIERS	PLACE	SUB-SUPPLIER APPL STATUS AS PER NTPC	SC APPL SCHEDULE	REMARKS
8.	Battery Health Monitoring System	I	7			Elteek	Gurgaon	DR		
						Emerson	Mumbai	DR		
						Hitachi Hirel	Gandhinagar	DR		
						HBL Power System	Hyderabad	A		
						Statcon	Hapur	DR		
						Hoppekke	Germany	DR		
9.	Fire Sealing System i) Type – A material supplier	III				M/s 3M India	Bangalore	A		
						M/s GE Silicon	USA	A		
						M/s Dow Corning	USA	A		
	ii) Type – B Material supplier	III				M/s Lloyds	Delhi	A		
						M/s Signum	Nagpur	A		
						M/s Vijay System Engineers Pvt. Ltd.	Mumbai	A		
						M/s Multikil Fire	Vadodara	DR		
						Murugapa Morgan	Ranipet	DR		
						Unifrax India	AHMEDABAD	DR		
	iii) Execution Agency for above					Same as 9 (ii) & 3 M India	Same as 9 (ii) & 3 M India	A		
10.	GI cable trays, fitting	I	8			Inar Profiles Ltd	Enkapalli	A		

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Patratu Vidyut Utpadan Nigam Limited C & M Deptt. Distt-Ramgarh(Jharkhand)

एनटीपीसी NTPC	PROJECT :Patratu STPP (2X660 MW) PACAKGE :EPC Sub Package: Electrical Equipment Supply & Erection CONTRACTOR : M/S BHEL CONT. NO. CS-9585-001-2	LIST OF ITEMS REQUIRING QP APPROVAL & ACCEPTABLE VENDOR Contractor-M/S BHEL	REF NO : 9585-001-QOE-R-01 REVISION NO. 00 DATE 24th April 2017

Sl. No.	ITEM	QP / INS CAT.	QP No:- 9578-001-QVE-	QP SUB. SCH.	QP APPL SCHEDULE	SUB-SUPPLIERS	PLACE	SUB-SUPPLIER APPL STATUS AS PER NTPC	SCAPPL SCHEDULE	REMARKS
	& accessories including bends					Vatco	Mumbai	A		Galvanization at Sigma Mumbai
						Indiana cable trays	Mumbai	A		Galvanization at Karamtara galvaniser
						Industrial Perforation	Kolkata	A		
						Ratan Engineering	Kolkata	A		Galvanization at B.P. Projects
						India Electric Syndicate	Kolkata	A		Galvanization at BMW Industries/B.P Projects
						Steelite engg.	Mumbai	A		
						Premier Power Products	Kolkata	A		Galvanising at Neha Galvaniser
						Indiana Gratings	Pune	A		Galvanization at Poona Galvanizer/ Anand Yeknow Aids Engg
						M.J. Engineering	Okhla/ Bhiwadi	A		
						Jamna Metal	Delhi/ Kundli	A		
						T.R.G	Chennai	A		Galvanization at TM Radhakrishna Chetty & Co
						Amtech	Pune	A		Galvanization at B.G. Shirke - Pune
						Kannade Anand Udyog	Mumbai	A		Fabrication at their units: Plot No. 42, Moriv District Thane & Plot No.: D-35 Anand Nagar MIDC, Addl. Ambernath , Dist.Thane Galvanization and offer the galvanized cable trays for inspection at D-34 Anand Nagar MIDC, Addl. Ambernath, Dist.Thane.
						Rukmani	Raipur	A		Ladder type cable trays only
						Passive Infra	Hasangarh (Rohtak)	A		
						Unitech Fabricators &	Howrah/	A		

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एनटीपीसी NTPC	PROJECT :Patratu STPP (2X660 MW) PACAKGE :EPC Sub Package: Electrical Equipment Supply & Erection CONTRACTOR : M/S BHEL CONT. NO. CS-9585-001-2	LIST OF ITEMS REQUIRING QP APPROVAL & ACCEPTABLE VENDOR Contractor-M/S BHEL	REF NO : 9585-001-QOE-R-01 REVISION NO. 00 DATE 24th April 2017

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						Engineers	Hoogly (Kolkata)			
						Patny System	Hyderabad	A		Galvanisation at Gurpreet galvaniser - Hyderabad
						Rabi Engg	Kolkata	A		Galvanizing from NTPC approved sources
						Advance Power Products	Howrah	A		
						Maheswari Electricals	Noida	DR		
						Saral Industries	Raibareli	DR		
						Parmar Metal	Rajkot	DR		
						Pentax	Mumbai	DR		
						Eros metal	Nagpur	DR		
						Vinfab	Thane	DR		
						Namdhari	Ludhiana	DR		
						Indmark Formtech	PUNE	DR		
11.	Cable tray flexible support system (GI)	I	9			Vatco	Mumbai	A		Galvanising at Sigma Mumbai
						Inar profiles	Enkapalli	A		
						Industrial perforations	Kolkata	A		
						Premier power products	Kolkata	A		Galvanising at Neha Galvaniser
						Steelite engg.	Mumbai	A		
						Indiana gratings	Pune	A		Galvanising at Poona Galvaniser
						Amtech	Pune	A		Galvanising at B.G. Shirke
						Ratan Projects	Kolkata	A		Galvanization at NTPC approved sources
						Indmark Formtech	PUNE	DR		
12.	Lead coated steel flexible conduits	III				M/s PLICA	Ghaziabad	A		
						M/s Lapp	Germany	DR		
						M/s Bansal Labs	Bhopal	A		

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Patratu Vidyut Utpadan Nigam Limited ★ C & M Deptt. ★ Distt-Ramgarh(Jharkhand) ★

एनटीपीसी NTPC	PROJECT :Patratu STPP (2X660 MW) PACAKGE :EPC Sub Package: Electrical Equipment Supply & Erection CONTRACTOR : M/S BHEL CONT. NO. CS-9585-001-2	LIST OF ITEMS REQUIRING QP APPROVAL & ACCEPTABLE VENDOR Contractor-M/S BHEL	REF NO : 9585-001-QOE-R-01 REVISION NO. 00 DATE 24th April 2017

Sl. No.	ITEM	QP / INS CAT.	QP No:- 9578-001-QVE-	QP SUB. SCH.	QP APPL SCHEDULE	SUB-SUPPLIERS	PLACE	SUB-SUPPLIER APPL. STATUS AS PER NTPC	SCAPPL SCHEDULE	REMARKS
13.	Junction boxes / Link Boxes/ Test Link Box/ Adopter box, Switch Boxes, Pull Boxes (Hot Dip Galvanized)	III				Main contractor approved sources with galvanization from NTPC approved sources (Note-2)		Noted		
14.	FRP Junction boxes	II	10			Main Contractor approved sources		Noted		
15.	Cable termination kits & straight through jointing kit upto 33KV	I	11			M/s 3M Electro & Communication	Pune	A		up to 33 KV
						Raychem	Mumbai	A		Heat shrinkable type up to 33 KV
						Yamuna Cable Accessories	Yamunanagar	DR		
						Hari Consolidated Pvt Ltd	Delhi	A		Heat shrinkable type Upto 11 KV with conditions, above rating DR
16.	Cable glands	III				Main contractor approved sources		Noted		
17.	Cable lugs	III				M/s Dowell	Mumbai	A		
						M/s Billets Elektro Werke Ltd.	Umbergaon	A		

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Patratu Vidyut Utpadan Nigam Limited Distt-Ramgarh(Jharkhand) C & M Deptt.

एनटीपीसी NTPC	PROJECT :Patratu STPP (2X660 MW) PACAKGE :EPC Sub Package: Electrical Equipment Supply & Erection CONTRACTOR : M/S BHEL CONT. NO. CS-9585-001-2	LIST OF ITEMS REQUIRING QP APPROVAL & ACCEPTABLE VENDOR Contractor-M/S BHEL	REF NO : 9585-001-QOE-R-01 REVISION NO. 00 DATE 24th April 2017

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						(3 D)				
						M/s Chetna	Nasik	A		
						Additionally Any make's model with VDE or CE or UL or CSA marking or BIS approved with CML no. Refer Note-3		Noted		
18.	Lighting fixtures with accessories	I	12			M/s Crompton	Mumbai	A#		#- "A"- for filament type and " DR" for LED Type
						M/s Bajaj Electricals	Mumbai	A		
						M/s Philips	Noida	A#		
						M/s Wipro	Mumbai	A		
						M/s Surya Rosini	Kashipur	A		
						M/s Goldwyn	Noida	A		
19.	Lamps	III				M/s Crompton	Mumbai	A#		#- "A"- for filament type and " DR" for LED Type
						M/s Bajaj Electricals	Mumbai	A		
						M/s Philips	Noida	A#		
						M/ s Wipro	Mumbai	A		
						M/s Surya Rosini	Kashipur	A		
						Goldwyn	Noida	A		
20.	Lighting Panels	I				Please refer seriel no- 3 as identified in LT Switchgear & LT Busduct sub package list				

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21.	DG set Control panel / Synchronising panel	I	14			L&T.	Mumbai / Coimbatore	A		
						GE	Bangalore	A		
						Siemens	Mumbai	A		
						C&S Electric	Noida / Hardwar	A		
						Schneider	Nasik	A		
						Unilec	Gurgaon	A		
						Switching Circuits	Kolkata	A		
						Tricolite	Sahibabad / Mancsar	A		
						Hindustan Control & equipment Ltd	Kolkata	A		With fabrication & painting at unit II & MP Electrical Narendrapur
						Maktel	Vadodara	A		
						Jakson	Greater Noida	A		
						Vidyut Control	Gaziabad	A		
						Adlec Power	Rohad (Jhajjar)	A		
						Pyrotech	Udaipur	A		
						Anand Power Ltd.	Noida	A		
						Positronics	Vadodara	A		
						M/s Sterling Generators Pvt Ltd	Silvasa	A		For DG Set Control Panel only
						Contro & Schematics	Hyderabad	A		
22.	Industrial /welding receptacles & boxes	III				Schneider	Nasik	A		
						M/s BCH	Faridabad	A		

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एनटीपीसी NTPC	PROJECT :Patratu STPP (2X660 MW) PACAKGE :EPC Sub Package: Electrical Equipment Supply & Erection CONTRACTOR : M/S BHEL CONT. NO. CS-9585-001-2	LIST OF ITEMS REQUIRING QP APPROVAL & ACCEPTABLE VENDOR Contractor-M/S BHEL	REF NO : 9585-001-QOE-R-01 REVISION NO. 00 DATE 24th April 2017

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						M/s Ajmera	Mumbai	A		
						M/s. Sakthi & Crown	Chennai	A		
						Additionally Any make's model with VDE or CE or UL or CSA marking or BIS approved with CML no		Refer Note-3		
23.	Lighting mast with raise & lower type lantern carriage	I	15			M/s Bajaj	Pune	A		
						M/s Skipper	Howrah	A		
						M/s. B.P. Project,	Hoogly	A		
24.	Lighting pole / steel tubular pole	I	16			BIS licensee as per IS 2713 with valid CMLnumber		A		
25.	Lighting poles polygonal type	I				M/s Bajaj	Pune	A		
						M/s B.P. Projects	Hoogly	A		
26.	PVC conduit/hume pipe/lighting wire/GI pipes/HDPE pipe/Structural Steel	III				BIS licensee / ISI marked with valid CML number		A		
27.	GI steel rigid conduit/ epoxy conduit	III				BIS licensee with valid CML number		A		

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एनटीपीसी NTPC	PROJECT :Patratu STPP (2X660 MW) PACAKGE :EPC Sub Package: Electrical Equipment Supply & Erection CONTRACTOR : M/S BHEL CONT. NO. CS-9585-001-2	LIST OF ITEMS REQUIRING QP APPROVAL & ACCEPTABLE VENDOR Contractor-M/S BHEL	REF NO : 9585-001-QOE-R-01 REVISION NO. 00 DATE 24th April 2017

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28.	Trefoil clamps/Earthing & Lighting Protection Material/Sheet Steel/ FRP cable trench cover/drum lifting jack/Earth wire/ FRP/Aluminum Ladder/Dimmer & Passive Infrared Sensors	III				Main Contractor Approved Sources		Noted		
29.	FAN with regulators & Exhaust Fan	III				M/s Crompton		Noted		
						M/s Orient				
						M/s Khaitan				
						M/s Polar				
						M/s GEC				
						M/s Havells				
						M/s Bajaj				
30.	FQP of DG Set Installation.	I	G-01							
31.	FQP of Cables & Accessories	I	G-02							

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एनटीपीसी NTPC	PROJECT :Patratu STPP (2X660 MW) PACAKGE :EPC Sub Package: Electrical Equipment Supply & Erection CONTRACTOR : M/S BHEL CONT. NO. CS-9585-001-2	LIST OF ITEMS REQUIRING QP APPROVAL & ACCEPTABLE VENDOR Contractor-M/S BHEL	REF NO : 9585-001-QOE-R-01 REVISION NO. 00 DATE 24th April 2017

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32.	FQP of Earthing	I	G-03							
33.	FQP of Station Lighting	I	G-04							

NB:
Under Sub Supplier approval status as per NTPC column:
A: mean that vendor for this item is acceptable to NTPC.
Under QP / INSPN CATEGORY column:

CAT-I : For these items the Quality Plans approved by NTPC & final acceptance will be on physical inspection & witness by NTPC

CAT-II : For these items the Quality Plans approved by NTPC. However no physical inspection shall be done by NTPC. The final acceptance by NTPC shall be on basis of verification of documents as per approved QP
CAT-III : For these items Main supplier approves the Quality Plans. The final acceptance by NTPC shall be on basis of certificate of conformance by the main supplier.
@ : Vendors acceptance is subject to sub-QR clearance.
Note-1- Approval conditions attached to above identified vendors, as applicable shall be adhered to.
Note-2 – List of NTPC acceptable galvanizers

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★ Patratu Vidyut Utpadan Nigam Limited ★ Distt-Ramgarh(Jharkhand) C & M Deptt.

एनटीपीसी NTPC	PROJECT :Patratu STPP (2X660 MW) PACAKGE :EPC Sub Package: Electrical Equipment Supply & Erection CONTRACTOR : M/S BHEL CONT. NO. CS-9585-001-2	LIST OF ITEMS REQUIRING QP APPROVAL & ACCEPTABLE VENDOR Contractor-M/S BHEL	REF NO : 9585-001-QOE-R-01 REVISION NO. 00 DATE 24th April 2017

Sl. No.	ITEM	QP / INS CAT.	QP No:- 9578-001-QVE-	QP SUB. SCH.	QP APPL SCHEDULE	SUB-SUPPLIERS	PLACE	SUB-SUPPLIER APPL STATUS AS PER NTPC	SC AP PL SC HE DU LE	REMARKS

1. M/s M J Engg,Delhi 2. M/s Jamna Metal,Delhi 3. M/s A.V. Engg, Kolkata 4. M/s Inar Profiles, Vishakapatnam 5. M/s Anand Udyog, Mumbai 6. M/s Techno Engg,Chandigarh 7. M/S Steelite Engg, Mumbai	8. M/s National Galvanizer, Kolkata 9. M/s Unistar Galvanizer, Kolkata 10. M/s B.P. Project. Kolkata 11. M/s Bajaj Pune 12. M/s Electrocare Industries, Mumbai 13. M/s B.G. Shirke, Pune 14. M/s Gurpreet Galvanizer, Hyderabad 15. M/s Sigma, Mumbai	16. M/s Radhakrishnan Shetty, Chennai 17. Karamtara Mumbai 18.Poona Galvanizers Pune 19. Neha Galvanizer- Kolkata 20. Unitech galvanizers- Hoogly 21. Gurpreet galvanizers- Hyderabad 22- DMP Projects- Kolkata	*Additional galvanizer/s , if any , proposed by manufacturer through main contractor during detailed engineering shall be reviewed & assessed by NTPC as per the merits of the case.*

Note-3 : VDE / CE / UL / CSA MARKING FOR PRODUCT QUALITY: SELF CERTIFICATION/VALID CERTIFICATION FROM THIRD PARTY AGENCY OR BIS APPROVAL LETTER WITH CML NO. FOR PRODUCT QUALITY SHALL BE SUBMITTED FOR NTPC's INFORMATION

NTPC

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Patratu Vidyut Utpadan Nigam Limited ★ Distt-Ramgarh(Jharkhand) ★ C & M Deptt.

(JATIN GAHLAWAT)
BHEL

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	PROJECT: PATRATU STPS EXPANSION PHASE - I (3X800MW) Package: EPC Sub Package : Switchyard No.: CS-9585-601-2		Contract	ANNEXURE - LIST OF ITEMS REQUIRING QUALITY PLAN APPROVAL AND ACCEPTABLE SUB-VENDOR AS PROPOSED BY M/S. BHEL					DOC.NO. : 9585-601-2 REV.NO. : 0 DATE : 03.04.2017	
S.No.	Item Description	QP/Insp Cat	QP#9591-001C QVE-Q	QP Sub-schedule	QP Approval Schedule	Proposed Sub-Supplier	Place	Sub-Supplier Approval status/ category	Sub-supplier details submission schedule	Remarks
1	400 kV Gas Insulated Switchyard	I	10			GE T&D	CHENNAI	A		
	(Item subject to Sub QP approval)					HYOSUNG	KOREA	A		
						XIAN	CHINA	A		
						ABB	VADODARA	DR		
						SIEMENS	AURANGABAD	DR		
2	400kV Capacitor Voltage Transformers	I	50			GE	Hosur	A		
	(Item subject to Sub QP approval)					ABB	Vadodara	A		
						BHEL	Bhopal	A		
						CGL	Nasik	A		
3	400 kV Surge Arrestors	I	60			OBLUM	Hyderabad	A		
	(Item subject to Sub QP approval)					CGL	Nasik	A		
						LAMCO	Hyderabad	A		
4	400 kV Wave Trap	I	70			GE	Hosur	A		
						BPL	Palghat	A		
						BPEG	CHINA	A		
						QUALITY POWER	SANGLI	DR		
5	Bus Post Insulator	I	80			ADITYA BIRLA	Halol	A		
						IEC	Bhopal	A		
						MODERN INSULATORS	Abu Road	A		
						WSI	Chennai	A		
6	Disc Insulator	I	90			ADITYA BIRLA	RISHRA (WB)	A		
						BHEL	Bhopal	A		
						IEC	Bhopal	A		
						MODERN INSULATOR	ABU ROAD	A		
						WSI	Chennai	A		
7	Aluminium Tube	I	100			Alom Extrusions	Kolkatta	A		
						HINDALCO	ALUPURAM	A		
						HINDALCO	Renukut	A		
						Jindal AL Tube	Bangalore	A		
						SUDAL	Nasik	A		
8	ACSR Conductor	I	110			APAR	Silvassa	A		
						DIAMOND	Vadodra	A		
						GUPTA POWER INFRA	Bhubaneshwar	A		

Bharat Heavy Electricals Limited PS-MKTG Delhi

C & M Deptt.

(Meeru Kashyap) NTPC

S.No.	Item Description	QP/Insp Cat	QP#9591-001C QVE-Q	QP Sub-schedule	QP Approval Schedule	Proposed Sub-Supplier	Place	Sub-Supplier Approval status/ category	Sub-supplier details submission schedule	Remarks
						ANVIL CABLES	JAMSHEDPUR	A		
						JSK	Silvassa	A		
						SHARAVATHY	Bangalore	A		
						DYNAMIC CABLES PVT LTD	JAIPUR	A		
						HUIL	GUWAHATI	DR		
						HUIL	GWALIOR	A		
						SHASHI CABLES	LUCKNOW	A		
9	1.1kV Grade Power, Control Cables	I	120							Refer Cabling List
10	Substation Automation System BCU, GRP, Energy Meter, Numerical Relays Switchyard Protection	I	130			ABB	Peenya	A		
	(item subject to Sub QR approval)					SIEMENS	Kalwa	A		
						SCHNEIDER	Noida	A		
						GE	Chennai	A		
						BHEL	Bhopal	A*		* Approved only for C&R panel
11	Components for Control & Relay Panels, Protection Panels, Islanding Scheme & Bay Control Unit									* : Inspection category of the item shall be same as mentioned in MQP of SAS
a	Energy Meter	*				Conzerv	Bangalore	A		
	(item subject to Sub QR approval)					Elster	Mumbai	A		
						GEC Meters	UK	A		
						Landis & GYR	Switzerland	A		
						SEMS	Udaipur	A		
b	EVENT LOGGER	*				GE T&D	UK / FRANCE	A		
						HATHWAY	UK	A		
c	TIME SYNCHRONIZING EQUIPMENT	*				ARBITER	USA	A		
						HOPF	GERMANY	A		
						HATHWAY	UK / USA	A		
						SERTEL	CHENNAI	A		
						SIEMENS	GERMANY	A		
						Masibus	Gandhinagar	A		
d	RELAY TEST KIT	*				OMICRON	USA/AUSTRALIA	A		
						DOBBLE	USA	A		
						MEGGER	UK	A		
e	DISTURBANCE RECORDER	*				GE T&D	USA	A		
						SIEMENS	GERMANY	A		
						ABB	FINLAND	A		

Bharat Heavy Electricals Limited PS-MKTG Delhi

C & M Deptt. Engg. Div./QAI

S.No.	Item Description	QP/Insp Cat	QP#9591-001C QVE-Q	QP Sub-schedule	QP Approval Schedule	Proposed Sub-Supplier	Place	Sub-Supplier Approval status/ category	Sub-supplier details submission schedule	Remarks
						HATHWAY	UK	A		
1	LARGE VIDEO SCREEN (LVS)	*				DELTA	Gurgaon	A		
						BARCO	Noida	A		
						Planner	USA	A		
6	RELAYS	*				ABB	Sweden / Bangalore	A		
	(Item subject to Sub QR approval)					GE T&D	UK/CHENNAI	A		
	(NUMERICAL AND AUXILLARY)					SCHNEIDER	UK/France	A		
						SIEMENS	GERMANY	A		
						SCHNEIDER	Noida/Chennai	DR		
12	Instrumentation Cable	I	140							Refer C&I List
13	BMK	I	150			BCH	FARIDABAD	A		
						C&S	Noida	A		
						Jakson	Noida	A		
						MAKTEL	VADODARA	A		
						Pyrotech	Udaipur	A		
						Schneider	Nashik	A		
						Spaceage Switchgear	Gurgaon	A		
						Unilec Switchgear	Gurgaon	A		
						Industrial Switchgear & controls	Thane	DR		
						MILESTONES	GURGAON	DR		
						ULTIMA SWITCHGEARS	ROORKEE	DR		
						Samcom Industrial Controls	Thane	DR		
						RST Electricals	Sahibabad	DR		
						Nitya Electrocontrols Pvt Ld	Noida	A		
						ENTERPRISING ENGINEERS	BHOPAL	DR		
						VIKAS POWER EQUIPMENTS PVT. LTD.	LUCKNOW	DR		
14	Lighting Pole	III	160							Refer Elect. Eq. List
15	Clamps & Connectors and Welding Sleeves	III				EMTT	Kolkata	A		
						EXALT	MUMBAI	A		
						KLEMMEN	Chennai	A		
						PEE VEE ENGG	Bangalore	A		
						Raychem	Vadodara	A		
						Vensun Techo Links	Chennai	DR		
						Premier Power Products	Chennai	DR		
						Deccan Engg Works	Bangalore	A		
16	Insulator Hardware	II	170			EMI	Mumbai	A		
						EMTT	Kolkata	A		

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C & M Engg. Div./QAI Dept.

S.No.	Item Description	QP/Insp Cat	QP#9591-001C-QVE-Q	QP Sub-schedule	QP Approval Schedule	Proposed Sub-Supplier	Place	Sub-Supplier Approval status/ category	Sub-supplier details submission schedule	Remarks
						IAC	Kolkatta	A		
						ITPL	Mumbai	A		
						RUL	Kolkatta	A		
						TAG CORPORATION	CHENNAI	A		
						Raychem (Tyco)	Bangalore	DR		
17	LIGHTING MAST	III						A		Refer Elect. Eq. List
18	AC KIOSK	I	180			I COMM TEL	HYDERABAD	A		
						Isolloyd	Baddi	A		
						JINDAL MECTEC	GURGAON	A		
						U-FOAM	HYDERABAD	A		
						SVARN TELECOM	HARDWAR	A		
19	JB (All Types) / Lighting Panel	II	190			C&S	Noida	A		
						Jakson	Greader Noida	A		
						MAKTEL	BARODA	A		
						Pyrotech	Udalpur	A		
						Schneider	Nashik	A		
						Space Switchgear	Gurgaon	A		
						TRICOLITE	SAHIBABAD	A		
						Unitec Switchgear	Gurgaon	A		
						DANISH	JAIPUR	DR		
						Nitya Electrocontrols	Noida	DR		
						MILESTONES	GURGAON	DR		
						ULTIMA SWITCHGEARS	ROORKEE	DR		
						ENTERPRISING ENGINEERS	BHOPAL	DR		
						VIKAS POWER EQUIPMENTS PVT. LTD.	LUCKNOW	DR		
20	OPGW CABLE	I	200			SUZHOU FURUKAWA	NOIDA	A		Accessories under CAT-III from
						STERLITE TECHNOLOGIES	SILVASSA	A		
21	Leakage Current Analyser	III				ISA	ITALY	A		
						APPLIED TECHNO PRODUCTS PVT. LTD.	GURGAON	DR		
						Scope T&M	Pune	A		
						DOBLE ENGG	USA	A		
						JOSTS ENGINEERING CO. LTD.	DELHI	DR		
						HI-TECH SYSTEMS & SERVICES LTD.	KOLKATA	DR		
22	SF6 GAS FILLING AND EVACUATING PLANT, GAS RECYCLING & PURIFYING PLANT, GAS LEAKAGE DETECTOR	III				AI QUALITEK	USA	A		
						DILO	GERMANY	A		
						ENERVAC	CANADA	A		
						VACCUUM PLANT INDUSTRIES	PUNE	A		

Bharat Heavy Electricals Limited ★ PS-MKTG Delhi

C&M Dept.

S.No.	Item Description	QP/Insp Cat	QP#9591-001C QVE-Q	QP Sub-schedule	QP Approval Schedule	Proposed Sub-Supplier	Place	Sub-Supplier Approval status/ category	Sub-supplier details submission schedule	Remarks
						WIKA	USA	A		
						Manik Motors	Hyderabad	DR		
23	OPERATIONAL ANALYSER WITH DCRM KIT	III				OMICRON	USA	A		
						DOBBLE	USA	A		
						SCOPE	PUNE	A		
						VIC	USA	A		
24	GS Flat / MS Flat / 40 MM Dia. M.S. Rod / M.S. Earth Rods/U Clamp / GI Earth Pipe / GI Pipe / GI Conduit (including Bends) / PVC Pipes	III				Main Contractor Approved Sources				
25	Cable Tray, Bends, Coupler Plates	III								Refer Cabling List
26	Cable glands	III								Refer Cabling List
27	Cable Lugs	III								Refer Cabling List
28	Lighting Fixtures & Luminaries	III								Refer Elect. Eq. List
29	Industrial Receptacles	III								Refer Elect. Eq. List
30	GS Earthwire / Lighting Wire	III				Main Contractor Approved Sources				
31	Transmission Line Tower Accessories (Danger Plate, Vibration Dampers, Number Plate, Phase Plate, Circuit Plate,Hanger Rod, ACD, Bird Guard, J Bolt, U Bolt, D Shackle, Barbed Wire, etc)	III				Main Contractor Approved Sources				
32	EOT Crane	I								Refer CHP List
33	Air Conditioning and Ventilation System	III								Refer AC Ventilation List
34	Fire Protection System	III								Refer Fire Protection List
35	AC for AC Kiosk	III								Refer AC Ventilation List

Note

1 SYSTEM SUPPLIERS/SUB-SUPPLIERS APPROVAL STATUS CATEGORY(SHALL BE FILLED BY NTPC)
A-For this items proposed vendor is acceptable to NTPC.To be indicated with letter "A" in the list along with condition of approval,if any
DR-For these items "Detailed required for NTPC review.To be identified with letter "DR" in the list.

Bharat Heavy Electricals Limited PS-MKTG Delhi

C & M Deptt

S.No.	Item Description	QP/Insp Cat	QP#9591-001C QVE-Q	QP Sub-schedule	QP Approval Schedule	Proposed Sub-Supplier	Place	Sub-Supplier Approval status/ category	Sub-supplier details submission schedule	Remarks
	NOTED- For these items vendors are approved by Main Supplier & accepted by NTPC without specific vendor approval from NTPC. To be identified with "NOTED"									
2	QP / INSPN CATEGORY CAT-I :For these items the Quality Plans approved by NTPC & final acceptance will be on physical inspection witness by NTPC CAT-II For these items the Quality Plans approved by NTPC.However no physical inspection shall be done by NTPC.The final acceptance by NTPC shall be on basis of documents as approved QP CAT-III For these items Main supplier approves the Quality Plans.The final acceptance by NTPC shall be on basis of certificate of conformance by the main supplier.									
3	UNITS/WORKS : Place of manufacturing Place of Main Supplier of multi units/works									
4	For GIS at Sr. No. 1 above, BHEL will follow their Standard procedures & Corporate guidelines and shall comply with circulars / instructions etc. issued by GOVT. / Relevent statutary bodies while tendering. However, for new vendors, BHEL shall take approval from NTPC prior to order placement.									

(ABHINAV GUPTA, BHEL) (DIPTOJIT, BHEL) (SEVAK, BHEL) (Muneem Kalyep) NTPC

Bharat Heavy Electricals Limited PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited C & M Deptt. Dist-Ramgarh(Jharkhand)

NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR :BHEL Ltd	VENDOR AS APPROVED BY	DATE : 28.04.2017
	CONTRACT NO : CS-9565-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9565-001-QVI-Q	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
1	DDC MIS / HMI System	I				SIEMENS	Gurgaon / Germany	#				# - Final acceptance subjected to system specific acceptance from NTPC Engg
		I				M/s BHEL (MAX DNA)	Bangalore	#				
2	Operator work stations	III				Main Contractor approved Sources		A				
3	Flame Monitoring System (SCANNER)	II				Forney	USA	A				
		II				ABB	Bangalore	A				Bought out item shall be finalised during detailed engineering
		II				Durag	Bangalore	A				
		II				BFI	Germany	A				
		II				BHELSCAN	Trichy	A				
		*				Fossil Power System Inc.	Canada	DR				
4	HEA Igniter	III				Unison Industries	USA	A				
		III				Durag	Germany	A				
		II				Durag	Bangalore	A				Make Durag, Germany
		III				Ignition system INC	USA	A				
		III				Tesi	Italy	A				
		I				Hindustan Thermometer	Ambala	A				Conditional
		*				Hainworthy Peabody Combustion Inc.	UK	DR				
		*				Forney	USA	DR				
5	Furnace Flame viewing system (High Temperature CCTV Components)	II				Diamond Power	USA / Sweden	A				
		II				TLT Engg Pvt. Ltd.	Kolkata	A				M/s Dimanond Power, USA / Sweden make system
		II				Mirion	UK	A				
		II				Toshniwal Industries	Ajmer	A				M/s Mirion, UK make System
		II				Lenox	USA	A				
		II				Iti Tech System and Service	Kolkata	A				M/s Lenox, USA make System
		II				Durag	Germany	A				
		II				Durag	Bangalore	A				M/s Durag, Germany make System
		II				Sabota GmbH	Germany	A				
		II				Piper GmbH	Germany	A				
		*				Tempsens	Udaipur	DR				System integrator for Piper GmbH, Germany.
6	Coal Flow Monitoring System	II				PROMECON	GERMANY	A				
		II				SWR Engg	GERMANY	A				
		II				EU Tech	GERMANY	A				
		*				Transweing	India	DR				
		*				Technomark Engginers & Consultant	India	DR				M/s BHEL will forward only two proposals after details review of NTPC Technical specification requirements
		*				Slock Redeller	India	DR				
		*				Greenbank Engery Systems	UK	DR				

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C & M Deptt.

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NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR :BHEL Ltd	VENDOR AS APPROVED BY	DATE : 26.04.2017
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9585-001-QVI-Q	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
		*				Berthold	Germany	DR				requirements.
		*				EDIT	Germany	DR				
7	Acoustic pyrometers	II				M/s Scientific Environment Instrument Inc	USA	A				
		II				M/s Bonnenberg + Drescher GmbH,	Germany	A				
		II				Lucent	Delhi	A				M/s Scientific Environmental Instrument Inc., USA make system
		II				Hi Tech	Kolkata	A				M/s Bonnenberg + Drescher GmbH, Germany make system
		*				Hanaefertech	Korea	DR				
8	Coal feeder conirol system	II				Stock	USA	A				
		II				Merick	USA	A				
		I				Stock Redeller	Bangalore	A				Main components from Stock, USA
		I				Merick	Bangalore	A				Main components from Merick, USA
		I				BHEL	Trichy	A				
9	Acoustic Coal Flow Detector	III				Stock	USA	A				
		III				Merrick	USA	A				
		*				Stock Redeller	Bangalore	DR				
		*				Merrick	Bangalore	DR				
10	On line carbon in Ash Analyser	II				Greenbank Engery Systems	UK	A				
		II				ABB	Bangalore	A				
		II				Promecon	GERMANY	A				
		II				Berhold Technologies	Germany	A				
		*				M and W	Denmark	DR				M/s BHEL will forward only one proposal after details review of NTPC Technical specification requirements.
		*				EMERSON	India	DR				
		*				Yokogawa	Bangalore	DR				
		*				Forbes Marshall	Pune	DR				
11	Furnace Exit Gas Temperature Probe	III				Main Contractor approved Sources	India /UK/USA					
12	Boiler tube leak detection system	II				Procon	UK	A				
		II				Raman Instruments	Delhi	A				M/s Procon, UK make System
		II				Acoustic Monitoring International Inc.	USA	A				
		II				Hi Tech System and Service	Kolkata	A				M/s AMI, USA make System
		II				Instoltech	South Africa	A				
		II				Rectusan	Korea	A				
		II				BHELSONIC	Trichy	A				
13	Coal bunker Level monitor	%				%						% - Type, vendor and inspection category will be decided during detail Engineering

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Bharat Heavy Electricals Limited ★ PS-MKTG Delhi

C & M Deptt. ★ Patratu Vidyut Utpadan Nigam Limited ★ Distt-Ramgarh (Jharkhand) ★

NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR :BHEL Ltd	VENDOR AS APPROVED BY	DATE : 26.04.2017
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9585-001-QVIQ	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
14	Tube thicknes Meter	III				Main Contractor approved sources		A				
15	POSITIVE DISPLACEMENT FLOW METER/ TRANSMITTER	III				BROOKS	USA	A			Sub QR	Calibration reports to be submitted.
		III				BOPP & ROUTHER	GERMANY	A				
		III				OVAL	JAPAN	A				
		II				Toshniwal corporation Hyvac	Chennai	A				Up to 4 Inch only
16	Coriolios Type Mass Flow meter	III				Main Contractor approved Sources		A			Sub QR	
17	Control Valve for Start Up System	II				CCI	USA/Switzerland/Korea	A				
		II				Tyco Sampell	Germany	A				
		II				EMERSON (Fisher)	USA/France/Japan	A				Reference list and performance feedback are to be submitted.
		*				Dressor Masoneilan	France	DR				
		II				KOSO	Japan / Nasik	A				
		II				HORA	Germany	A				
		II				CCI	Srlcity	A				
18	Control valves for Soot blower pressure reducing ,SH/ RH Attemperation.	II				CCI	USA/Sweden /Korea / Austria	A				
		II				Dressor Masoneilan	France	A				
		II				HORA	Germany	A				
		II				EMERSON (Fisher)	USA/France /Japan	A				
		II				Spx Copes Vulcan	USA	A				only for SH / RH Attemperation, for Soot blower application Reference to list to be provided.
		II				KOSO	JAPAN	A				
		II				Tyco Sampell	Germany	A				
		II				Leslie	USA	A				
		I				Dressor	Coimbatore	A				Up to 2500 Class
		I				IL	Palakkad	A				Up to 2500 Class
		I				KSB MIL	Ajwaye	A				
		I				KOSO	Nasik	A				
		I				EMERSON	Chennai	A				Up to 2500 Class
		I				Flow Serve	Bangalore	A				Up to 2500 Class
		I				CCI	Srlcity	A				
		*				Copes Vulcan	UK	DR				
		*				Circor (Leslie)	Coimbatore	DR				
19	Control Valve for BFP Recirculation	II				CCI	USA / Austria / Korea	A				
		II				EMERSON (Fisher)	USA/France/Japan	A				
		II				Dressor Masoneilan	France	A				
		II				HORA	Germany	A				
		*				Sempell	Germany	DR				M/s BHEL will forward only three proposals after details review of NTPC Technical specification
		*				Leslie	USA	DR				
		I				CCI	Srlcity	A				

Bharat Heavy Electricals Limited ★ PS-MKTG Delhi

C & M Deptt. Dist-Ramgarh(Jharkhand)

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NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR :BHEL Ltd	VENDOR AS APPROVED BY	DATE : 26.04.2017
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9585-001-QVI-Q	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
		*				KOSO	Japan / Nasik	DR				requirements.
		*				Nakikata	Japan	DR				
		*				Parcol Spa	USA	DR				
		*				Yamatake	Japan	DR				
		*				BOPP & ROUTHER	Germany	DR				
		*				KSB MIL	Alwaye	DR				
20	Control valve for feedwater flow Control	II				CCI	USA/Austria /Korea	A				
		II				Dressor Masoneilan	France	A				
		II				HORA	Germany	A				
		II				EMERSON (Fisher)	USA/France /Japan	A				
		II				Sampell	Germany	A				
		II				KOSO	Japan	A				
		*				LESLIE	USA	DR				M/s BHEL will forward only three proposals after details review of NTPC Technical specification requirements.
		I				CCI	Sricity	A				
		*				Parcol Spa	USA	DR				
		*				WEIR VALVES and Controls	UK	DR				
		*				KOSO	Nasik	DR				
		*				KSB MIL	Alwaye	DR				
		I				Emerson Process Management	Channai	A				
		*				BOMAFA Special valve solutions Pvt. Ltd.	Ahmedabad	DR				
		*				Suzhou delan enfery science and tehnology co. Ltd.	China	DR				
21	Control Valve (other than Sr. No. - 17 to 20)	II				CCI	USA/Switzerland/Korea	A				
		II				Tyco Sampell	Germany	A				
		II				EMERSON (Fisher)	USA/France/Japan / Chennai	A				
		II				Dressor Masoneilan	France	A				
		II				KOSO	Japan	A				
		II				HORA	Germany	A				
		II				CCI	Sricity	A				
		II				Spx Copes Vulcan	USA	A				
		II				Dressor	Coimbatore	A				
		II				IL	Palakkad	A				
		II				KSB MIL	Alwaye	A				
		II				KOSO	Palakkad	A				
		II				EMERSON	Chennai	A				
		II				Flow Serve	Bangalore	A				
		II				Copes Vulcan	UK	A				
		II				Leslie	USA	A				
		II				Parcol Spa	Italy	A				
		II				KOSO	Nasik	A				

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Bharat Heavy Electricals Limited PS-MKTG Delhi

C.E. (Water) Deptt.

NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR :BHEL Ltd	VENDOR AS APPROVED BY	DATE : 26.04.2017
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9585-001-QVI-Q	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
		II				Forbes Arca	Pune	A				Approvd up to 4" and 300 Class. "DR" for Higher rating and Size.
		*				Daume Regelamaturean GmbH	Germany	DR				M/s BHEL will forward only three proposals after details review of NTPC Technical specification requirements.
		*				Metso Singapore PTE ltd.	South Korea	DR				
		*				Severn Glocon	Chennai	DR				
		*				Spx Corporation	USA	DR				
		*				Ringo Valvulas SL	Spain	DR				
		*				Valvitalia SPA	Italy	DR				
		*				R K Controls	Thane	DR				
		*				Circor (Leslie)	Coimbatore	DR				
		*				Spx Flow Technologies	USA	DR				
		*				Circor (Leslie)	Coimbatore	DR				
		*				Schenjiang valve co. ltd.	China	DR				
		*				Spx Flow Technologies	Ahamadabad	DR				
		*				WEIR Valves and Controls	UK	DR				
		*				WALDEMAR PRUSS ARMATURENFABRIK GMBH	Germany	DR				
		*				BOMAFA Special valve solutions Pvt. Ltd.	Ahmedabad	DR				
		*				Suzhou delan enfery science and tehnology co. Ltd.	China	DR				
22	Temperature Transmitter	III				EMERSON	U.S.A/Pawane / Singapore	A			Sub QR	
	(Single and Duel Input)	III				Yokogawa	Japan	A				Final testing at M/S YIL,Bangalore is also acceptable
		III				Moore	USA	A				
		III				M System	JAPAN	A				
		III				ABB	GERMANY/ Bangalore	A				
		III				ENDRESS & HOUSER	Aurangabad	A				
		*				Khrone		DR				M/s BHEL will forward only two proposals after details review of NTPC Technical specification requirements.
		*				Tokyo Kelso	Japan	DR				
		*				Honeywell	Pune	DR				
		*				INOR	Sweden	DR				
		*				P & F	Bangalore	DR				
		*				Siemens		DR				
		*				Yamatake	JAPAN	DR				
		*				Yamari	JAPAN	DR				
		*				Foxboro		DR				
23	Conduits/Pipe(GI)					Refer Electrical List						
24	Electronic transmitters (pressure, DP,Flow)	III				EMERSON (Rosemount)	USA/ Pawane	A			Sub QR	
		III				FUJI ELECTRIC	France	A				
		III				YOKOGAWA	JAPAN	A				Testing and Calibration at M/s YIL, Bangalore is also acceptable.

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Bharat Heavy Electricals Limited PS-MKTG Delhi

NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR :BHEL Ltd	VENDOR AS APPROVED BY	DATE : 26.04.2017
	CONTRACT NO : CS-9565-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9565-001-QVIQ	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
		III				YOKOGAWA	Bangalore	A				EJA- E series 110,430,530
		III				ABB	Bangalore	A				Model - 2600 T
		III				ABB	GERMANY / Italy	A				Model - 2600 T
		III				Siemens	France / Kalwa	A				
		III				Honeywell	Pune	A				
		III				Laxson Automation	Daman	A				SMAR Make
		III				Baldota	Mumbai	A				SMAR Make
		*				ENDRESS & HOUSER	Aurangabad/ Germany	DR				
		*				CHINO	Ghaziabad	DR				
25	Thermocouples, RTD & Thermowell	III				HERAUS SENSOR	GERMANY	A			Sub QR	
		III				WISE Control	Korea	A				
		II				Tempsens	Udaipur	A				
		II				Pyroelectric	Goa	A				
		II				Detriv Instrumentation & Electronics Ltd	Mumbai	A				
		III				Minco	USA	A				
		III				OKAZAKI corperation	JAPAN	A				
		III				Yamari	JAPAN	A				
		III				Yamari	Singapore	A				For RTD Reference list and Performance feedback is to be submitted.
		III				ABB(SENSYCON)	Germany	A				
		III				EMERSON (Rosemount)	Germany	A				
		II				EMERSON (Rosemount)	Pawane	A				Imported from Emerson, Germany (make)
		II				Thermal Instruments(GIC)	Savanwadi	A				
		II				Techno Instruments	Ahamadabad	A				
		II				GOA Instrument Industries	GOA	A				For Thermowell only
		*				GOA Instrument Industries	GOA	DR				M/s BHEL will forward only two proposals after details review of NTPC Technical specification requirements.
		*				WIKA	Pune	DR				
		*				Toshniwal Industries	Ajmer	DR				
		*				E & H	Aurangabad	DR				
		*				Nesstech	Vapi	DR				
		*				Instrustial Instruments	Kolkatta	DR				
		*				Exotherm	Thane	DR				
		*				Baumer Technologies	Vapi	DR				
		*				Eleind Engineering	Noida	DR				
		*				Siemens India	Gurgaon	DR				
		II				Jindal Electronics	Roorkee	A				For Gentrator,turbine & Motor
26	Ultrasonic type level Transmitter	III				E & H	Aurangabad/ Germany	A			Sub QR	
		III				EMERSON	Pawane	A				
		III				SIEMENS MILTRONICS	CANADA	A				
		III				Nivelco	Hungery	A				
		*				Vega	Germany	DR				

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Bharat Heavy Electricals Limited PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited C & M Deptt. Distt. Ramgarh (Jharkhand)

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NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR :BHEL Ltd	VENDOR AS APPROVED BY	DATE : 26.04.2017
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9585-001-QVI-Q	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
		*				Khrone	France / USA / Pune	DR				M/s BHEL will forward only two proposals after details review of NTPC Technical specification requirements.
		*				Yokogawa	Bangalore	DR				
		*				P&F	Germany	DR				
		*				Magnetrol	Belgium	DR				
		*				ABB	Germany / India	DR				
		*				Fobes Marshell	Pune	DR			Sub QR	
27	Orifice plate assembly	III				Instrumentation Limited	Palghat	A				
		III				Microprecision	Patwal	A				
		III				Starmech	Pune	A				
		III				Flow Star	Faridabad	A				
		III				SEIKO	Austria	A				
		III				MINCO India Pvt. Ltd.	GOA	A				Up to 32"
		III				MINCO India Flow Elements Pvt. Ltd.	GOA	A				Up to 28"
		III				WISE Control	Korea	A				
		III				T M Technomatic	Italy	A				
		*				IEPL	Hyderabad	DR				
		*				Engg. Specialities	Kolkata	DR				
		*				BALIGA	CHENNAI	DR				
		*				Pyroelectric	Mumbai	DR				
		*				Hydropneumatics	Mapusa	DR				
		*				Tansa Equipment Pvt. LTd.	Thane	DR				
		*				Dynamic Fluid Vales Pvt. Ltd.	Belgaun	DR				
28	Pressure, DP Gauge	III				BUDENBERG	UK	A				
		III				ASHCROFT	USA/Germany/ India	A				
		III				Wika	GERMANY	A				
		III				WISE Control	Korea	A				
		III				Nagano KEIKI	Japan	A				
		III				H.Guru South India	Bangalore	A				Not for MS & FW application
		III				A.N. Instruments	Kolakata	A				Not for MS & FW application
		III				Gauge Bourdon	Panvel	A				
		III				Goa Thermostatic	GOA	A				Not for MS & FW application
		III				Wika	Pune	A				DR for MS & FW application
		III				Baumer	Vapi	A				DR for MS & FW application
		III				Precision mass products Pvt. Ltd.	Gandhinagar	A				Not for MS & FW application
		III				H Guru	Rishra/Muzaffarpur	A				Not for MS & FW application
		*				US Gauge	USA	DR				
		*				Winters	USA	DR				
		III				Forbes Marshall	Hyderabad	A				
		*				Manometer	Mumbai	DR*				
		III				Walchandnagar Industries Ltd.	Dharwad	A				
		III				Nesstech	Vapi	A				DP Gauge for M/s Nesstech, Japan
		*				Gauges Bourdon	UK	DR				
		*				Fisher Mess	Germany	DR				

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Bharat Heavy Electricals Limited * PS-MKTG Delhi *

C & M Deptt.

Patratu Vidyut Utpadan Nigam Limited * Distt-Ramgarh(Jharkhand)

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NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR :BHEL Ltd	VENDOR AS APPROVED DY	DATE : 26.04.2017
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9585-001-QVI Q	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
		*				Protech Control	Kolkata	DR				
		*				New Scientific	Kolkata	DR				
		*				PTCI	Kolkata	DR				
29	Level gauge (Transperent & Reflex, Tubular type)	III				Main Contractor approved Sources		A				
30	Press, DP, Vaccum Switch	III				SOR	USA	A			Sub QR	
		III				DRESSOR (ASHCROFT)	USA/Germany	A				
		III				ITT BARTON	USA	A				
		III				HERION	GERMANY	A				
		III				BARKSDALE	GERMANY	A				
		*		*		Nagano KEIKI	Japan	DR				
		II				Switzer Process Instrument	Chennai	A				Up to 40kg/cm2 & not for Compound Switch and except 900 series
		II				Trafag	Gurgaon	A				Up to 40kg/cm2 & not for Compound Switch
		II				Switzer Process Instrument	Ghaziabad	A				Up to 40kg/cm2 & not for Compound Switch
		III				Delta control	UK	A				
		I				Gauges Bourdon (GIC)	Panvel	A				Up to 40kg/cm2 & not for Compound Switch
		I				ASHCROFT	Gandhinagar	A				
		*				Wika	Pune	DR				
		III				Gorgeion	France	A				
		III				United Electric	USA	A				M/s BHEL will forward only two proposals after details review of NTPC Technical specification requirements.
		*				SMC	Japan	DR				
		*				Neodyne	USA	DR				
		*				IMI NORGEN	Noida	DR				
		*				WISE Control	Korea	DR				
		*				Baumer	Vapi	DR				
		*				Vasu Tech	New Delhi	DR				
		III				Bell & Krich	Germany	DR				
31	Temperature Switch	III				SOR	USA	A			Sub QR	
		III				DRESSOR (ASCHROFT)	USA/Germany	A				
		III				ITT BARTON	USA	A				
		III				DELTA CONTROLS	UK	A				
		I				Switzer Process Instrument	Chennai	A				up to 200 Deg. C
		I				Switzer Process Instrument	Ghaziabad	A				up to 200 Deg. C
		II				Trafag	Gurgaon	A				up to 200 Deg. C
		I				ASHCROFT	Gandhinagar	A				
		*				Wika	Pune	DR				
		III				Gorgeion	France	A				
		III				United Electric	USA	A				
		*				SMC	Japan	DR				
32	Flow switch	III				UNIVERSAL FLOW METER	USA	A			Sub QR	
		III				Switzer	Chennai	A				

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Patratu Vidyut Utpadan Nigam Limited C & M Deptt. Distt-Ramgarh (Jharkhand)

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NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR :BHEL Ltd	VENDOR AS APPROVED BY	DATE : 26.04.2017
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9585-001-QVIQ	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
		III				Levcon	Kiokatta	A				
		III				DK Instrument	Kolkatta	A				
		III				Khrone Marshal	Pune	A				
		III				Chemtrol	India	DR				
		III				V Automat	NewDelhi	DR				
		III				Gauges Bourdon	Panvel	A				
		III				Magnetrol	Belgium	A				
		III				Ashcroft	Germany	A				
		III				Auxitrol	UK	A				
		III				Mericoid	USA	A				
		III				Delta Control	UK	A				
		III				Merlum	USA	A				
		*				Sunag Corporation		DR				
33	Condensing Pots	III				Main Contractor approved Sources		A				
34	Electric to Pneumatic converter	III				IMI NORGEN	India	A			Sub QR	Make : WATSON SMITH
		III				Fair child	USA	A				
		*				ABB	India	A				Subject to meeting the NTPC specificaion requirement
		*				SMC Pneumatics	Noida	DR				
		*				P & F	Bangalore	DR				
		*				Fairchild India Pvt. Ltd.	Noida	DR				
		*				FESTO	Bangalore	DR				
35	Conduits lead coated (Flexible)	III				Plica	Ghaziabad	A				Main contractor can propose additional vendor for this item
		III				Bansal labortories	BHOPAL	A				
36	Intelligent Battery charger 24V DC & DCDB /BHMS	II				Chabbi Electricals	Jalgaon	A			Sub QR	Modules from EMERSON
		II				Eltech	Gurgaon	A				Modules from ELTEK
		II				MasTech	Jalgaon	A				Modules from ELTEK
		II				Emerson	India	A				
		II				MasTech (Selek Modules)	Jalgaon	A				BHMS from M/s USV, Germany
		*				HBL Power Systems	India	DR				
		*				Dobas	India	DR				
		*				Chabbi Electricals (Chabbi Modules)	Jalgaon	DR				
		*				Hitachi Hi Rel	Gandhinagar	DR				
		*				Statcon Power Controls Pvt. Ltd.	Noida	DR				
		*				Chloride Power Systems (caldyne)	India	DR				
		*				Amararaja	Tirupati	DR				
		*				Keltron Power Electronics	Trivendram	DR				

M/s BHEL will forward only two proposals after details review of NTPC Technical specification requirements.

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Patratu Vidyut Utpadan Nigam Limited * Distt-Ramgarh (Jharkhand) * C & M Deptt.

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NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR :BHEL Ltd	VENDOR AS APPROVED BY	DATE : 26.04.2017
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9585-001-QVIQ	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
		*				Universal instrument manufacturing co P Ltd	India	DR				
		*				Hind Rectifier Ltd	India	DR				
37	Battery Health Monitoring System	III				Emerson	Mumbai	A				
		III				Eltek SGS Pvt Ltd	Gurgaon	A				
		*				B Tech Inc	USA	DR				
		III				Hitachi Hi Rel	Gandhinagar	A				
		*				Hopeckes	Germany	DR				
		*				Hitachi Hi Rel	Gandhinagar	DR				
38	Battery(Ni-cd)	I				AMCO SAFT	Bangalore	A				
		II				SAFT	France/Sweeden	A				
		I				HBL POWER	Hyderabad	A				
		II				Hopekee	Germany	A				
39	Socket weld fittings	III				BHEL Approved Sources						
40	Impulse pipe & tubes	II				Mahrashtra Seamless	Raigarh	A				Carbon steel only
		II				Sumitomo/kawasaki/Nippon	Japan	A				
		II				TPS TECHNITUBE	Germany	A				
		II				Veluric & manessmann	Germany	A				
		II				BHEL	Trichy	A				
		II				Trouvay and Cauvin	France	A				Makes shall be as per apprvoed list (Sr. No. 41)
		II				ISMT	Ahamadnagar	A				Carbon steel only.
		II				Sandvik		A				For SS only.
		*				TUBACES	Spain	DR				
		*				Salzgitter Mannesmann International	Germany	DR				
		*				Jindal saw	India	DR				
		II				Ratanamani Metal and Tubes	Ahamadabad	A				SS only
		II				Heavy metals and Tubes	Ahamadabad	A				SS and CS only.
		*				Shubhalaxmi Metal and Tubes	Mumbai	DR				
41	Compression fittings	III				Parker	USA	A				
		III				Precision	Mumbai	A				
		III				Asiech	Mumbai	A				
		III				Fluid control Pvt. Ltd.	Pune	A				
		III				HP Valves and fittings	CHENNAI	A				Ferruleas are to be hardned at Exim Holand for pressure above 9000 psi.
		III				Excel hydro	Mumbai	A				Ferruleas are to be hardned at Exim Holand for pressure above 9000 psi.
		III				Swagelock	USA	A				
		III				Panam	Mumbai	A				
		III				Metpress	Kolkatta	DR				
		*				AURA INC	New Delhi	DR				
		*				Prima Engineers		DR				
		*				Arya Craft		DR				

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C&M Dept. Patratu Vidyut Utpadan Nigam Limited Distt-Ramgarh (Jharkhand)

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NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR :BHEL Ltd	VENDOR AS APPROVED BY	DATE : 26.04.2017
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9585-001-QVIQ	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
		*				PMT Engineers	Ahemdabad	DR				
		*				Flowtech	Kolkatta	DR				
		*				Parker Hannfin India Pvt Ltd		DR				
42	Instrument valves	III				BHEL	Trichy	A				
		II				Excel Hydro	Mumbai	A				
		II				Instrumentation Ltd.,	Palghat	A				
		III				Swagelok	USA	A				
		III				Parker	USA	A				
		II				HP Valves and fittings	CHENNAI	A				
		II				Fluid control Pvt. Ltd.	Pune	A				
		II				Baldota	Mumbai	A				
43	Valve manifolds	III				Excel hydro	Mumbai	A				
		III				SCHNEIDER	Germany	A				
		III				Anderson Greenwood	USA	A				
		III				Astech	Mumbai	A				
		III				HP Valves and fittings	CHENNAI	A				
		II				Fluid control Pvt. Ltd.	Pune	A				
		III				Microprecision	Faridabad	A				
		III				Parker	USA	A				
		III				Swagelock	USA	A				
		III				Baldota	Mumbai	A				
		*				Metpress Engg. works	Kolkata	DR				
		*				Flow tech	Kolkata	DR				
44	Local Instrument Enclosure/Rack	I				Pyrotech	Udaipur	A				
		I				Instrumentation Limited	Kota	A				
		I				Sajas electrical	Trichurapalli	A				
		I				Prammen	Puddukottai	A				
		I				Chemin	Pondicherry	A				
		*				Forbes Marshall	Pune	DR				
		*				Pasitronics	Vadodara	DR				
		*				Procon	Chennai	DR				
45	Instrument Cables	I				Paramount	Khushkhera	A				PVC,FRLS type,ROP
		I				Polycab	Daman	A				PVC,FRLS type,ROP
		I				Delton	Faridabad	A				PVC,FRLS type,ROP
		I				KEI	Bhiwadi	A				PVC,FRLS type
		I				Elkey Telelinks	Faridabad	A				PVC,FRLS type
		I				CORDS	Chopanki	A				PVC,FRLS type,ROP
		I				CORDS	Kaharani	A				PVC,FRLS type,ROP
		I				Nicco	Kolkata	A				PVC,FRLS type
		II				TEW & C	USA	A				
		II				Habia cables	Sweeden	A				
		II				Kerpen cables	Germany	A				
		II				Lapp cables	Germany	A				
		II				Thermo electra Bv	Netherland	A				
		I				Universal Cable	Satna	A				PVC,FRLS type
		I				Thermocables	Hyderabad	A				PVC,FRLS type

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C & M Deptt. Patratu ★ Distt.Ramgarh(Jharkhand) ★ Limited

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NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR :BHEL Ltd	VENDOR AS APPROVED BY	DATE : 26.04.2017
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9585-001-QVIQ	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
		I				Finolex Cable	Pune	DR *				
		I				Incab	Pune	DR *				
		I				Gupta Power Infrastructure Ltd.	Khurdha	A				
		*				Lapp cables	India	DR				
		*				Lioni cable	Pune	DR				
		*				RR Kabel	Silvasa	DR				
		*				Gemscab	Bhiwadi	DR				
		*				KEC International	Mysore	DR				
		*				Advance cable Technologies	Bangalore	DR				
		*				Suyog Electricals Ltd.	Vadodara	DR				
		*				Special Cable	India	DR				M/s BHEL will forward only two proposals after details review of NTPC Technical specification requirements.
		*				CMI	Faridabad	DR				
		*				Govind Cables	Kolkata	DR				
		*				Associate Cables	Mumbai	DR				
		*				Radiant RSCC Speciality	Hyderabad	DR				
		*				APAR Industries	Banglore	DR				
		*				Tempsens Cable	Udaipur	DR				
		*				Mansfield cables co. Ltd.	Hyderabad	DR				
		*				Servel India Pvt. Ltd.	Neemrana	DR				
		*				TC Communication Pvt. Ltd.	Ghaziabad	DR				
46	Electrical actuator	III				Auma	Germany	A				
		III				Limitorque	USA	A				
		III				Rotorq	UK	A				
		II				Limitorque	Faridabad	A				
		II				Rotork	Chennai/ Bangalore	A				
		III				Nippon gear	Japan	A				
		II				Auma	Bangalore	A				
		III				Harold Beck	USA	A				
		III				Orehmo	Germany	A				
		I				Antrieb	Chennai	A				For Low torque application such as SH/RH vent, circulation isolation
		*				Lindoo	USA	DR				
		*				Siemens	Germany	DR				
47	Electrical actuator for ID/FD/PA Blade pitch and Guide vane control	III				Harold Beck	USA	A				
		III				SIPOS Aktronik GmbH	Germany	A				
		*				ABB	Germany	DR				
48	Flow nozzle / Venturi assembly	II				Microprecision	Faridabad	A			Sub QR	
		II				SEIKO	Austria	A				
		II				TECHNOMATIC	Italy	A				
		II				Instrumentation Limited	Palghat	A				
		I				Starmech	Pune	A				
		II				WISE Control	Korea	A				

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C & M Deptt. Patratu Vidyut Utpadan Nigam Limited Distt-Ramgarh(Jharkhand)

NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR :BHEL Ltd	VENDOR AS APPROVED BY	DATE : 26.04.2017
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9585-001-Q/VIQ	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
		I				MINCO India Flow Elements Pvt. Ltd.	GOA	A				
		*				SAMIL	Korea	DR				
		*				MINCO	GOA	DR				
		*				Engg. Specialities	Kolkata	DR				
		*				Pyroelectric	Mumbai	DR				
		*				Hydropneumatics	Mapusa / GOA	DR				
		*				ASIAN INDUSTRIAL VALVES	Chennai	DR				
		*				Dynafluid valves Pvt. Ltd.	Belgium	DR				
49	HIGH Temp. cable (PTFE/FEP)	II				Habia cables	Sweden	A				
		II				Lapp cables	Germany	A				
		II				Kerpen cables	Germany	A				
		II				TEW & C	USA	A				
		II				Thermo-Electra Bv	Netherland	A				
		II				Habia cables	China	A				
		II				Thermocables	Hyderabad	A				
		II				Tempsens	Udaipur	A				
		*				Delton Cables	Faridabad	DR				
		*				RJ Cables	Roorkee	DR				
50	Fiber optic cable	II				HFCL	Goa	A				
		II				R&M	Switzerland	A				
		II				Aksh Fibre	Bhiwadi	A				
		II				Finolex	Pune/Goa	A				
		II				Birla Ericson	Rewa	A				
		II				Molex	UK	A				
		II				Corning	USA	A				
		II				Schneider	GOA	A				Previously known as D Link / Smartlink, Goa
		*				RPG Cables	India	DR				
		*				Unilex Cables	India	DR				
		*				Terracom	India	DR				
51	Pneumatic Actuator (Power Cylinder e. g. FOR SADC)	II				Dong Woo Valve Control Co. LTD	Korea	A				
		II				Shin Hwa Engineering Co. LTD	Korea	A				
		I				Instrumentation Limited	Palghat	A				
		I				Kelton	Cochin(Alleppy)	A				
		I				SMC Pneumatics	Noida	A				Up to 12 Inch only
		I				Rotex	Mumbai	A				Conditional
		*				Emerson Process Management	Chennai	DR				
		*				MIL Controls	Alwaye	DR				
		*				Festo	Bangalore	DR				
		*				IMI Norgen	Noida	DR				
52	Level switch capacitance type	III				ENDRESS & HOUSER	Aurangabad	A			Sub QR	
		III				MAGNETROL	BELGIUM	A				
		III				SBEM	PUNE	A				
		III				PUNE TECHTROL	PUNE	A				

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C&M Deptt. Patratu Vidyut Utpadan Nigam Limited ★ Distt-Ramgarh (Jharkhand)

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NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR :BHEL Ltd	VENDOR AS APPROVED BY	DATE : 26.04.2017
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9585-*-001-QVI-Q	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
		III				LEVCON	KOLKATA	A				
		III				Nivo Controls	Indore	A				
		*				V AUTOMAT	New Delhi	DR				
		*				D K Instrument	Kolkata	DR				
		*				Siemens	Germany	DR				
		*				ABB	Korea	DR				
		*				Rosemount	Korea	DR				
53	Transducer	II				AE	Mumbai	A				
		II				Southern Transducer	Chennai	A				
		II				Elsler	Mumbai	A				
		III				Camille Bauer	Germany	A				
		III				Metrawat	Germany	A				
		II				Rishab	Nasik	A				
		*				Pyrotech	Udaipur	DR				
		*				Masibus	Gandhinagar	DR				
		*				SIEMENS	Germany	DR				
54	Mini UPS up to 3.5 KVA	III				EMERSON	Mumbai	A				
		III				EMERSON	Pune	A				
		III				Hitachi Hi- Rel	Gandhinagar	A				
		III				APC	Bangalore	A				
		III				APLAB	Mumbai	A				
		III				Delta	Gurgaon	A				
		*				Powertronix	Bangalore	DR				
		*				DUBAS ENGG.PVT.LTD., BANGALORE		DR				
		*				Grid power conversion Pvt Ltd.		DR				
		*				Schneider	Bangalore	DR				
55	Level switch- cond type	III				EMERSON (Solartron mobrey)	UK	A			Sub QR	
		II				Hi Tech	Kolkata	A				Levelstate, UK System
		III				Yarway	USA	A				
		III				LEVELSTATE	UK	A				
		II				Raman Instruments	Delhi	A				Emerson (Mobrey) System
		*				BHEL	Trichy	DR				
		*				IGEMA	Germany	DR				
56	Level switch - Float/Displacer Type	III				ENDRESS & HOUSER	AURANGABAD	A			Sub QR	
		III				MAGNETROL	BELGIUM	A				
		III				LEVCON	KOLKATA	A				
		III				SBEM	PUNE	A				
		III				Chemtrols samil	Mubmai	A				
		III				NAKATIYA	JAPAN	A				
		III				Sigma Industries	Mubmai	A				
		III				D K Instrument	KOLKATA	A				
		III				PUNE TECHTROL	PUNE	A				
		III				V AUTOMAT	NEW DELHI	A				
		*				WAREE	WAPI	DR				
		III				LEVELSTATE	UK	A				

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Bharat Heavy Electricals Limited PS-MKTG Delhi

C & M Deptt. Patratu Vidyut Utpadan Nigam Limited Distt-Ramgarh (Jharkhand)

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NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR :BHEL Ltd	VENDOR AS APPROVED BY	DATE : 26.04.2017
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9585-001-QVIQ	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
		III				Gauges Bourdon (GIC)	Panvel	A				
		*				Nisan Scientific Process	Navi Mumbai	DR				
57	Air filter regulator	III				Fairchild	USA	A				
		III				Shavo Norgen	Mumbai	A				
		III				SMC Pneumatics	NOIDA	A				
		III				Emerson (Asco)	Chennai	A				
		III				Festo	Bangalore	A				
		III				Placka	Chennai	A				
						Divya Control Elements	Gujarat	DR				
58	Copper tubing/Brass connectors	III				Main Contractor approved Sources		A				
59	Coupling / Interposing relays	III				PARAMOUNT	BANGALORE	A				
		III				OMRON		A				
		III				OEN		A				
		III				Jyoti	Baroda	A				
		III				ELSTA	SWITZERLAND	A				
		*				Schneider	Germany	DR				
		*				Siemens	Germany	DR				
		*				Phoenix	Germany	DR				
		*				Finder		DR				
60	Solenoid valve	III				Rotex	Vadodara	A			Sub QR	
		III				Avcon	Mumabi	A				
		III				Herion	Germany	A				
		III				IMI NORGEN	GERMANY	A				
		III				Jafferson	Argentina	A				
		III				Asco	Chennai/USA	A				
		III				Festo	Bangalore	A				
		III				SMC	Noida	A				
		III				Parker	Brand Name	A				
		*				Schneider	Germany	DR				
		*				Neucon Industries Pvt. Ltd.		DR				
61	Lube oil control valve - Self Regulating	III				NUOVO PIGNONE	ITALY	A				
		III				EMERSON	CHENNAI	A				
		III				SAMSON	GERMANY / PUNE	A				
		III				Forbes marshall arca pvt. Ltd.	Pune	A				Approved up to 16", 900 Class.
62	Guided waveRadar type level transmitter	III				Magnetrol	Belgium	A			Sub QR	
		III				Endress & Houser	Germany/ Aurangabad	A				
		III				Emerson Process Management	Sweden/ PAWANE	A				
		III				ABB(K-Tech)	USA	A				
		II				Supreme Technology	Thane	A				Make M/s Siemens, Canada
		*				Yokogawa	Japan	DR				
		*				ABB	India	DR				
		*				P & F	Bangalore	DR				

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NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR : BHEL Ltd	VENDOR AS APPROVED BY	DATE : 28.04.2017
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9585-001-QVI-Q	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
		*				Khrone	France	DR				
		*				HONEYWELL	Pune	DR				
		*				Vega	Germany / India	DR				
		*				Siemens	India	DR				
		*				SBEM	Pune	DR				
63	Maintenance and Calibration Equipment					Main Contractor will propose the vendors during detail Engineering.						
64	Temperature Gauge	III				BUDENBERG	UK	A				
		III				DRESSOR (ASHCROFT)	USA/Germany	A				
		III				Wika	GERMANY/ Pune	A				
		III				WISE Control	Korea	A				
		III				Nagano KEIKI	Japan	A				
		III				H.Guru South India	Bangalore	A				
		III				A.N. Instruments	Kolakatta	A				
		III				NUOVA FIMA	ITALY	A				
		III				Goa Thermostatic	Goa	A				
		III				Goa Instrument Industries	Goa	A				
		III				Baumer	Vapi	A				
		III				Precision mass products Pvt. Ltd.	Gandhinagar	A				
		III				H Guru	Rishra/Muzaffarpur	A				
		III				Baumer	Vapi	A				
		III				Forbes Marshall	Hyderabad	A				
		III				Gauges Bourdon (GIC)	Panvel	A				
		*				Konica	Korea	DR				
		*				Pyroelectric	GOA	DR				M/s BHEL will forward only two proposals after details review of NTPC Technical specification requirements.
		*				Winters Gauge	USA	DR				
		*				Walchandnagar Industries Ltd.	Dharwad	DR				
		III				Nasstech	Vapi	A				
		*				US Gauge	USA	DR				
65	Furniture for computer (Chair, Almirah, Lock etc.)	III				Main contractor approved sources		A				
66	Terminal Block (Cage and Clamp type)	III				Weidmuller	Germany	A				
		III				Phoenix	Germany / India	A				
		III				Wago	Germany / India	A				
		III				Elmex	Vadodara	A				CE Mark only
67	FRP Junction Box for C&I system	III				BHEL Approved Sources		A				
68	PLC System (if applicable)	I				GE Intellegent plateforms	Bangalore	A				
		I				ABB	Bangalore	A				
		I				Schneider	Nasik	A				
		I				Rockwell	Sahibabad	A				
		I				Siemens	Nasik	A				
		I				HONEYWELL	Pune	A				
69	SMART POSITIONER (Make)	#				ABB						# - To be covered in Control Valve QP.

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Bharat Heavy Electricals Limited PS-MKTG Delhi

C & M Deptt. Patratu Vidyut Utpadan Nigam Limited Dist-Ramgarh(Jharkhand)

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NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR : BHEL Ltd	VENDOR AS APPROVED BY	DATE : 26.04.2017
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9585-001-QVIQ	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
		#				Masoleinen						
		#				Siemens						
		#				Smar						
		#				Yokogawa						
		#				EMERSON (Fisher Rosemount)						
		#				METSO						
		#				Yamatake						
		#				Moore						
70	ROTAMETER	III				IEPL	HYDRABAD	A			Sub QR	
		III				TRAC	HYDRABAD	A				
		III				PLACKA	CHENNAI	A				
		III				EUREKA	PUNE	A				
		III				SCIENTIFIC DEVICES	MUMBAI	A				UP TO 300 NB
		III				FLOW STAR	FARIDABAD	A				
		III				TOKOYO KEISO	JAPAN	A				
		*				Flowtech Instrument Services	Vadodara	DR				
		*				Samil Chemtrol	MUMBAI	DR				
		*				Gauges Bourdon	Panvel	DR				
		*				Tansa Equipment Pvt. Ltd.	Thane	DR				
71	SINGLE AND MULTI POINT TEMPERATURE RECORDER (Microprocessor based)	III				YOKOGAWA INDIA	BANGALORE	A				Make Yokogawa, Japan
		III				CHINO CORPORATION	JAPAN	A				
		III				EUROTHERM	UK	A				
		III				EUROTHERM	INDIA	DR				
		III				YOKOGAWA	JAPAN	A				
		III				ABB	UK / GERMANY	A				
		III				FUJI	JAPAN	A				
		III				HONEYWELL	USA / NETHERLAND	A				
72	Reverse Rotation Indicator (RRI)	III				GE BENTLY NEVEDA	USA	A			Sub QR	ALL TSI VENDORS ARE ALSO ACCEPTABLE
		III				SHINKAWA	JAPAN	A				
		I				P & F	Bangalore	A				
73	Instrument Tube Fittings (Air)	III				Main contractor approved sources		A				
74	pH/ Conductivity Analyser	III				HACH	Switzerland / USA	A			Sub QR	
		III				YOKOGAWA	Banglaore / Japan	A				Make Yokogawa- Japan
		III				ABB	UK / USA	A				
		III				EMERSON	Pawane	A				
		*				Thermo orion		DR				
		*				Forbes Marshell	Pune	DR				
75	PADO					Main Contractor will propose the vendors during detail Engineering.						
76	DEW Point Sensor / meter/ Moisture Measuring System	III				GE Sensing	USA / Ireland	A				Panametric brand
		III				Michell Instrument	UK	A				
		III				Shaw	UK	A				

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C & M Deptt. Patratu Thermal Power Station Limited Distt-Ramgarh(Jharkhand)

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NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR :BHEL Ltd	VENDOR AS APPROVED BY	DATE : 28.04.2017
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9585-001-QVIQ	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
		III				COSA XENTAUR	USA	A				through Spectrum automation faridabad
		*				VAISHALA	Sweden / Japan	DR				
		*				DWER	USA	DR				
		*				Endee	Mumbai	DR				
		*				Nivo Controls	Indore	DR				
		*				Bartec GMBH	Germany	DR				
77	Blank Panels / Cabinets	III				Rittal	Bangalore	A				
		III				Hoffman	BANGALORE	A				
		III				Pyrotech	Udaipur	A				
		III				BHEL	Bangalore	A				
		III				Schneider	Bangalore	DR				
78	CCTV Components (IP)	*				Sony	Japan	DR				
		*				Siemens	Pondichery	DR				
	Integrators will be decided during detail Engineering.	*				Dv Tel	USA	DR				
		*				Honey Well	Gurgaon	DR				
		II				Bosch	Bangalore	A				With Bosch Software
		II				Axis	Sweden	A				With Bosch Software
		*				Pelco	USA	DR				
		II				Axis	Sweden	A				With Milestone Software
79	Control Desk, Server / PC Rack for Unit Control room and Auxiliary control room.	I				Pyrotech works Space	Udaipur	A				
		I				Cosmos	Noida	A				
		I				Adarsh Control	Bangalore	A				
		*				Chemin Controls	Pondichery	DR				
		*				Harmoney Systems	New Delhi	DR				
80	Digital Indicators	III				Masibus	Gandhi Nagar	A				For Non mosaic mounting
		III				ABB	Germany	A				
		III				Foxboro	UK	A				
		III				Yokogawa	Japan	A				
		III				Gossen / Metrowatt / Camille Bauer	Germany	A				
		III				Siemens	Germany	A				
		III				Chino	Japan	A				
		III				Weigell Messgerate	Germany	A				
		III				Pyrotech	Udaipur	A				For Non mosaic mounting
		*				Chino Corporation	Mumbai	DR				
		*				Yokogawa	Bangalore	DR				For Non mosaic mounting and submit only two proposals
		*				Lektrotek	Pune	DR				
		*				Telelherm	Chennai	DR				
81	Dust Emision Monitor	III				Land Instrument International	UK	A				Land Combustion Division
		III				Durag	Germany	A				
		III				Sick Maihak	Germany	A				
		III				Emerson Process Management	Ireland	A				
		III				Codel	UK	A				

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NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACT OR :BHEL Ltd	VENDOR AS APPROVED BY	DATE : 28.04.2017
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9585-001-QVIQ	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
		II				Forbes Marshall	Pune	A				Main kit from M/s Codel, UK
82	Electrical Indicating Instruments (Mosaic Compatible)	III				Siemens	Germany	A				
		III				Gossen / Metrowatt / Camille Bauer	Germany	A				
		III				Ganz	Germany	A				
		III				Weigell Messgerate	Germany	A				
83	Flue Gas Analyser (CO)	III				Codel	UK	A			Sub QR	
		III				Emerson Process Management	Pawane	A				Analyser from M/s Emerson, Germany / USA.
		III				Land Instrument International	UK	A				Land Combustion Div
		III				Sick Maihak	Germany	A				
		III				Siemens	Germany	A				
84	Flue Gas Analyser (CO2)	*				Codel	UK	DR			Sub QR	
		*				Sick Maihak	Germany	DR				
		*				Kiltwake Procal Ltd.		DR				
85	Flue Gas Analyser (SO2 and Nox)	III				Sick Maihak	Germany	A			Sub QR	
		III				Emerson Process Management	Pawane	A				Analyser from M/s Emerson, Germany / USA.
		III				Siemens	Germany	A				
		III				Fuji Electric	Japan	A				
		*				Yokogawa	Japan	DR				
		*				Codel	UK	DR				
		*				ABB	Gloucestershire	DR				
86	Flue Gas Analyser (O2 Analyser (HT))	II				SECO	Chennai	A			Sub QR	Main Contractor Can propose additional vendor for this item
		III				Marathon Monitor	USA	A				
87	Flue Gas Analyser (O2 Analyser (LT))	III				Emerson (Rosemount)	Pawane	A			Sub QR	Make EMERSON, USA
		III				Forbes Marshall	Pune	A				Make Enotec, Germany : Model Oxitec 5000 series
		III				ICE	Mumbai	A				Make Ametek, USA
		III				Yokogawa	Bangalore	A				Make Yokogawa, Japan
		III				ABB	Bangalore	A				Make ABB, UK
		*				AMETEK (P and AI division)	Singapore	DR				
		*				Enotec	Germany	DR				
		*				Fuji Electric	Japan	DR				
		*				Teledyne	USA	DR				
88	Flue Gas Analyser Panel	I				Chemtrol	Goa	A			Sub QR	
		I				Emerson Process Management	Navi Mumbai	A				
		I				Pyrotech	Udaipur	A				
		I				Analytical Instrument Company	Kota	A				Analyser from M/s Fuji, Japan
		I				Yokogawa	Bangalore	DR				
		I				Adage	Mumbai	A				
		*				Marvel Engg Company	Chennai	DR				

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NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR :BHEL Ltd	VENDOR AS APPROVED BY	DATE : 26.04.2017
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9585-001-QVI-Q	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
		*				Forbes Marshell Codel	Pune	DR				
						ICE(Asia) Private India	Mumbai	DR				
89	Graphic Interface Unit	III				Rockwell Automation		A				
		III				Digital Instruments and Control System (Preface)	Bangalore	A				Preface Brand
		III				Red Lion	USA	A				
		III				Schnieder Electric		A				
90	Hand Held Calibrator	III				Main contractor approved sources		A				Compatible with the Transmitter to be Supplied & Subject to meeting NTPC specification requirement
91	Hart Management System	III				Yokogawa	India	A				
		III				Emerson Process Mgmt	USA / Singapore / India	A				
		III				P & F	Germany / Bangalore	A				
		III				MTL	Chennai	A				
		*				Stahl	Germany	DR				
92	Impact Head Type Flow Element	II				Detriech / Emerson	USA	A			Sub QR	
		II				Midwest	USA	A				
		II				Veris Inc	USA	A				
		*				TM Technomatic SPA	Italy	DR				
93	Isolator	III				Main contractor approved sources						
94	Master Slave Clock System	II				Hopf	Germany	A				
		I				Sertel	Chennai	A				
		II				Hathway	USA	A				
		II				Moser Baer AG	Switzerland	A				
		II				Mein Berg	Germany	A				
		I				Sands	Chennai	A				
		I				Masibus	Gandhinagar	A				
		*				Signals & System	Chennai	DR				
95	Mosaic Tiles / Console Items	III				Pro-Plan	Germany	A				Earlier Boyko Strey
		III				Tew	Germany	A				Earlier Subklew
94	Network Components	III				Main contractor approved sources						
96	Online Mercury Analyser	III				Durag	Bangalore	A			Sub QR	Make Durag, Germany
		*				Malhak	Germany	DR				Main Contractor Can propose additional vendor for this item
		*				Thermo	USA	DR				
97	P A System (IP Based)	*				Commend	Austria	DR				
		*				Stantaphone Zenitel	Norway	DR				
		*				Armtel	Russia	DR				
		*				Industronic Industrie Electronic GmbH and Co. KG	Germany	DR				
		*				LARAON Enginners and Consultants Pvt. Ltd,	Gurgaon	DR				
		*				Alshan Technologies India Pvt. Ltd.	Bangalore	DR				

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E & M Deptt. Patratu Vidyut Utpadan Nigam Limited * Distt. Ramgarh (Jharkhand)

NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR :BHEL Ltd	VENDOR AS APPROVED BY	DATE : 26.04.2017
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9585-001-QVIQ	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
98	Printer (Dot Matrix)	III				BHEL Approved Sources						Make
99	Printer (Inkjet)	III				BHEL Approved Sources						Make
100	Printer (Laser)	III				BHEL Approved Sources						Make
101	Semaphore Indicators	III				Subklew	Germany	A				
		III				K & N	Austria	A				
		III				ABB	Germany	A				
		III				Siemens	Germany	A				
102	Synchronising Relay	III				Siemens	Mumbai	A			Sub QR	
		III				Areva	Chennai	A				
		III				ABB	Bangalore	A				
103	Synchroscope	III				BHEL Approved Sources		A			Sub QR	
104	Ultrasonic Type Flow Meter (for Stack)	III				Maihak	Germany	A			Sub QR	
		III				Durag	Germany	A				
		III				Teledyne	USA	A				
		*				GE Sensing	USA	DR				
105	UPS / ACDB	I				EMERSON (DB Power)	Pune	A			Sub QR	Approved up to 105 kVA, 1Φ
		I				Merlin & Gerin	France	A				
		I				Gutur	Switzerland	A				
		I				AEG (Safi)	Germany	A				
		I				Hitachi Hirel	Gandhinagar	A				Approved up to 150 kVA, 1Φ
		I				Emerson (Tata Liberl)	Ambamath	A				Approved up to 150 kVA, 1Φ
		I				Fuji Electric	Japan	A				
		*				Keltron	Kerala	DR				
		*				APC	India	DR				
		*				DUBAS ENGG.PVT.LTD., BANGALORE		DR				
		*				Grid power conversion Pvt Ltd.		DR				
106	Vibration Monitoring System for BOP	II / I				Shinkawa	Japan	A			Sub QR	
	Refer Note - 1	II / I				Bentley Nivada	USA	A				
		II / I				Vibrometer	Switzerland	A				
		II / I				Rockwell Automation	USA	A				
		II / I				SKF	USA	A				Refer Note - 1
		I				GE	Pune	A				GE Bently, USA make System
		I				Meggit	Bangalore	A				Vibromer, Switzerlerland make System
		I				Forbes Marshall	Pune	A				Shinkawa, Japan make System
		I				Rockwell Automation	Sahibabad	A				
		*				Emerson	Mumbai	DR				
		*				Burel and Kajer		DR				
		*				IRD Mechanalysis	Mumbai	DR				
107	Voltmeter	III				Rishabh	Nasik	A			Sub QR	
		III				AE	Mumbai	A				
		III				Yokogawa	Japan	A				
		*				MECO		DR				
108	Watthour Meters	III				L&T	Bangalore	A				

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Bharat Heavy Electricals Limited ★ PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited * Distt-Ramgarh(Jharkhand) * C&M Deptt.

NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR :BHEL Ltd	VENDOR AS APPROVED BY	DATE : 26.04.2017
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9585-001-QVIQ	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
		III				Elster	Mumbai	A				
		III				Secure Meters	Udaipur	A				
		III				Yokogawa	Japan	A				
		III				GEC	UK	A				
		III				Schnieder Electric	India	DR				
		III				Landis + Gyr	Kolkata	DR				
109	Wireless Solution (Microwave Tower Communication)	III				D Link	Goa	A				
		III				Sheetal	Pune	A				
		III				Pyrotech	Udaipur	A				
		III				Arya Communications	New Delhi	A				
		*				Lotus Wireless	Vishakhapatnam	DR				
		*				Avirion	Israel	DR				
		*				Prudent Automation Pvt. Ltd.	Hyderabad	DR				
		*				AMG Systems Ltd.	UK	DR				
110	Large Video Screen (LED Based)	III				Delta	Gurgaon	A				
		III				Barco	Noida	A				
		III				Planer System	USA	A				
		*				Christie	USA	DR				
		*				Eyevis	Germany	DR				
111	CJC Box (If applicable)					Main Contractor will propose the vendors during detail Engineering.						
112	3 D level Scanner for Solid Application	III				APM	ISRAIL	A				
113	Dust Sensor	III				BHEL Approved Sources		A				
114	Pulse jet Controller	III				Switching Circuit	Kolkata	A				
		III				Advance Concept	Kolkata	A				
		III				Control Devices	Kolkata	A				
		*				Vollcraft	Kolkata	DR				
		*				Micro System	Kolkata	DR				
115	Solid Mass Flow Meter	III				Schenk	Ranchi	A				
		III				Thermofisher (Ramsay)	Nasik	A				
		III				Siemens Miltronics	Canada	A				
		III				Mutec	Germany	A				
		III				SWR	Germany	A				
116	Nucleonic Density meter	III				E & H	Aurangabad	A				
		III				Thermofisher Scientific	UK	A				
		*				Siemens	Germany	DR				
		*				EMERSON	USA	DR				
		*				GE Sensing	USA	DR				
		*				Berthhold	Germany	DR				
117	Humidistat / Thermostat / Gyserstat / Airstat	III				BHEL Approved Sources		A			Sub QR	
118	Level Switch (RF Type)	II				EIP Enviro	Noida	A			Sub QR	
		II				FLOW STAR	Faridabad	A				
		II				Nivo Controls	Indore	A				
		*				BHEL		DR				

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Bharat Heavy Electricals Limited ★ PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited ★ Distt-Ramgarh(Jharkhand) Civil Deptt.

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NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR :BHEL Ltd	VENDOR AS APPROVED BY	DATE : 26.04.2017
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9585-001-QVIQ	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
119	Turbine supervisory instruments along with vibration analysis system.	II				GE BENTLY	USA	A				
	Refer Note - 1	II				MEGGITT (VIBROMETER)	SWITZERLAND	A				
		II				SHINKAWA	JAPAN	A				
		I				GE	Pune	A				For GE Bently, USA System
		I				MEGGITT (VIBROMETER)	Bangalore	A				For Meggitt, Switzerland System
		I				Forbes Marshall	Pune	A				For Shinkawa, Japan system
		*				EMERSON	INDIA	DR				
		*				Bruel and Kjaer		DR				
		*				Rockwell Automation	Sahibabad	DR				
		*				SKF	USA / India	DR				
		*				BHEL EDN	Bangalore	DR				
120	SWAS (Sampling Handling System and Dry Panel)	I				Emerson Process Management	Navi Mumbai	A			Sub QR	
		I				Forbes Marshall	Pune	A				
		I				Lowe	UK	A				
		I				ABB	Bangalore	A				Conditional
		I				Yokogawa	Bangalore	DR				
		I				Analyser Instrument Co. Ltd.	Kota	DR				
		I				Steam Equipment	Pune	A				
		*				Flow Line Instrumant	Bangalore	DR				
		*				Instrumentation Limited	Kota	DR				
		*				Chemin Controls	Pondichery	DR				
121	SWAS Analyser (Chloride)	III				ABB	UK	A			Sub QR	
		III				Orion	USA	A				Orion Brand
		*				DKK	Japan	DR				
122	SWAS Analyser (Conductivity)	III				Hach	Switzerland	A			Sub QR	Polymetron Brand
		III				Emerson Process Management	Navi Mumbai	A				
		III				Yokogawa	Japan	A				
		III				ABB	UK	A				
		*				Honeywell	USA	DR				
		*				DKK	Japan	DR				
		*				Orion	USA	DR				
123	SWAS Analyser (Dissolved Oxygen)	III				Orion	USA	A			Sub QR	Orion Brand
		III				Hach	Switzerland	A				Polymetron Brand
		III				Emerson Process Management	USA	A				
		III				ABB	UK	A				
		*				Honeywell	USA	DR				
		*				DKK	Japan	DR				
124	SWAS Analyser (Hydrazine)	III				Hach	Switzerland	A			Sub QR	Polymetron Brand
		III				Orion	USA	A				Orion Brand
		III				ABB	UK	A				

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Bharat Heavy Electricals Limited ★ PS-MKTG Delhi

C&M Deptt. Patratu Vidyut Utpadan Nigam Limited ★ Distt-Ramgarh (Jharkhand)

NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR :BHEL Ltd	VENDOR AS APPROVED BY	DATE : 26.04.2017
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9585-001-QVIQ	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
		*				DKK	Japan	DR				
		*				Rosemount Analytical Inc Irvine		DR				
125	SWAS Analyser (pH)	III				ABB	UK	A			Sub QR	
		III				Hach	Switzerland	A				Polymetron Brand
		III				Emerson Process Management	Navi Mumbai	A				
		III				Yokogawa	Japan	A				
		*				Honeywell	USA	DR				
		*				DKK	Japan	DR				
		*				Orion		DR				
126	SWAS Analyser (Phosphate)	III				Hach	USA	A			Sub QR	
		III				Hach	Switzerland	A				Polymetron Brand
		III				ABB	UK	A				
		*				DKK	Japan	DR				
		*				Orion	USA	DR				
		*				Rosemount Analytical Inc Irvine		DR				
127	SWAS Analyser (Silica)	III				Hach	USA	A			Sub QR	
		III				Hach	Switzerland	A				Polymetron Brand
		III				ABB	UK	A				
		*				DKK	Japan	DR				
		*				Orion	USA	DR				
		*				Rosemount Analytical Inc Irvine		DR				
128	SWAS Analyser (Sodium)	III				Hach	Switzerland	A			Sub QR	Polymetron Brand
		III				Orion	USA	A				Orion Brand
		III				ABB	UK	A				
		*				DKK	Japan	DR				
129	SWAS Analyser (Turbidity)	III				ABB	UK	A			Sub QR	
		III				Emerson	USA	A				
		III				WTW	Germany	A				
		III				E & H	Germany	A				
		*				DKK	Japan	DR				
130	Operator Testing Simulator					Main Contractor will propose the vendors during detail Engineering.						
131	Concentration Analyser					Main Contractor will propose the vendors during detail Engineering.						
132	Electromagnetic Flow Meter	II				Krohne Marshal	Pune	A			Sub QR	
		II				E & H	Aurangabad	A				
		II				Emerson	Pawane	A				
		III				Yokogawa	Japan / China	DR				Only Ref list and catalouges to be submitted.
		III				SIEMENS	Germany	DR				
133	Fiber Optic Generator End winding VMS	II				Vibro System INC	Canada	A				
		II				MC-Monitoring SA	Switzerland	A				Note-6
134	H2 Gas Analyser Cabinet	II				ABB	Bangalore	A				H2 Gas Analyser Germany
		II				Adage Automation	Mumbai	A				H2 Gas Analyser siemens Germany Model Calomat-6
		II				Yokogawa	Bangalore	A				H2 Gas Analyser from yokogawa Japan
		II				Siemens	India	A				H2 Gas Analyser siemens Germany

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Bharat Heavy Electricals Limited ★ PS-MKTG Delhi

Adage Automation Pvt. Ltd. Dispt. Ramgarh (Jharkhand)

NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR :BHEL Ltd	VENDOR AS APPROVED BY	DATE : 26.04.2017
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9585-001-QVI-Q	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
135	Sight Flow Indicator	III				BHEL Approved Sources		A				
136	Amonia Analyser	*				Sick Maihak	Germany	DR				
		*				Emerson Process Management	Pawane	DR				
		*				Siemens	Germany	DR				
		*				Fuji Electric	Japan	DR				
		*				Thermofisher	Mumbai	DR				
		*				Yokogawa	Banglore	DR				
		*				Dongwoo Optron		DR				
137	AAQMS	I				Environment SA India Pvt. Ltd.	Bangalore	A			Sub QR	Analysers for Environment SA, France : Multipoint Calibrator from M/s L N Industrial, Switzerland and Metrological Sensors from M/s LSI Lastem SRL, Italy.
		I				Chemtrols	GOA	A				Analysers for Teledyne API, USA: Metrological Sensors & SPM from M/s Metone Instruments, USA.
		I				Thermo Electron LLS India PVt. Ltd.	Mumbai	A				Analysers for M/s Thermoenvironmental Instruments Inc., USA & Metrological Sensors from M/s Metone Instruments, USA.
		*				Land Combustion	UK	DR				
		*				Thermofisher	India / USA	DR				
138	EQMS	*				SEPL	Pune	DR			Sub QR	
		*				AICPL	Kota	DR				
		*				Nevco	Surat	DR				
		*				Thermofisher	Mumbai	DR				
		*				Themax	Pune	DR				
		*				Supreme Technology	Mumbai	DR				
139	RESIDUAL CHLORINE ANALYSER	III				E & H	GERMANY	A				
						EMERSON PROCESS	PAWANE	A				
						HACH	USA	A				
140	ORP ANALYZER	III				Emerson process	USA/Pawane	A				
						ABB	UK/USA	A				
						HACH	Switzerland	A				
						Yokogawa	Japan	A				
141	CL2 Leak detector	III				W&T	Germany	A				
142	Flame Scanner Cable	I				Thermocable	Hyderabad	A				
		I				Delton cables	Faridabad	A				

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Heavy Electricals Limited * Bharat * PS-MKTG Delhi

Patratu Vidyut Utpadan Limited * C & M Deptt. * Dist:Ramgarh(Jharkhand)

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NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR :BHEL Ltd	VENDOR AS APPROVED BY	DATE : 26.04.2017
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9585-001-QVI-Q	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
		I				Cords Cable	Bhiwadi / Kaharani	A				

LEGENDS :

1.0 SYSTEM SUPPLIER / SUB SUPPLIER APPROVAL STATUS CATEGORY (SHALL BE FILLED BY NTPC)

A - For those items proposed vendor is acceptable to NTPC, subject to meeting the NTPC Specificaiton requirement. To be indicated with letter "A" in the list alognwith the condition of approval, if any.

DR - For those items "Detailed Required" for NTPC review. To be identified with letter "DR" in the list.

NOTED : For these items vendors are approved by Main Supplier and accepted by NTPC without specific vendor approval from NTPC. To be identified with "NOTED"

2.0 QP INSPECTION CATEGORY :
CAT - I : For those items the Quality Plans are approved by NTPC and final acceptance will be on physical inspection witness by NTPC
CAT - II : For those items the Quality Plans are approved by NTPC. However no physical inspection shall be done by NTPC. The final acceptance by NTPC shall be on the basis of review of documents.

CAT-III:

UNITS/WORKS : Place of manufacturing- Place of main supplier of multi units/works.

* - Inspection category will be decided during vendor evaluation.

NOTE - 1 : EMPTY CABINETS, COMPUTERS, SIGNAL ISOLATOR/ MULTIPLIER, MCB, TB, POWER SUPPLY ETC. SHALL ALSO BE ACCEPTABLE FROM INDEGENEOUS SOURCES AGREED BY NTPC IN QP. IF THE TOTAL INTEGRATED PANEL AND FAT IS CONDUCTED INDEGENEOUSLY ITEM TO BE TREATED AS CAT - I.
NOTE - 2 : Mandatory Sapre will be treated as CAT-III
NOTE - 3 : For the items not appearing in the preaward list, bidder and NTPC will mutually discussed in future.

NOTE - 4 : Intergration testing of DDCMIS shall be done with monitor connected to the LVS workstation. This would be tied up in the QAP/ATST. Dispatch of LVS can be allowed like a CAT-III item but only after successful testing of funcaality as indiacted in QP and completion of ATST of first unit.

NOTE - 5 : C&I items intergral for skid,Fan, Motor,Pump etc instrument shall be supplied as per OEM standred/ approved soureces.

NOTE - 6 : for instrumentation cable quantity less than 1 km of each type inspection category is III and for less then 2.5 km of each type inspection category is CAT-II

FORMAT NO. : QS-01-QAI-P-1/F3-R0

Engg. Div/QA&I

Bharat Heavy Electricals Limited PS-MKTG Delhi

P.P. Patil

PRASHANT P. PATIL
Dy.m (QA-C&F)

Amit Yadav
Mgr. MKTG.
BHEL

Bharat Heavy Electricals Limited C & M Deptt. Dist-Ramgarh(Jharkhand)

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	PROJECT: PATRATU STPP-I (3X800 MW)	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB- SUPPLIER APPROVAL				NTPC DOC NO	
एनटीपीसी NTPC	PACKAGE: EPC					REV. NO.	0
	MAIN SUPPLIER: BHEL	SUB SYSTEM: CIVIL WORKS				DATE	05.04.2017
	CONTRACT NO.: CS-9585-001-2						

SR. NO.	ITEM	QAP / INSP. CAT	QAP NO.	PROPOSED SUB SUPPLIER	PLACE OF MANUFACTURING	APPROVAL STATUS / CATEGORY	REMARKS
1.	**CEMENT**	III	-	BIS APPROVED SOURCES HAVING VALID BIS LICENCE	-	-	
2.	**CONSTRUCTION CHEMICALS - ADMIXTURES, PLASTISIZERS, RETARDERS WATER PROOFING COMPOUNDS GROUTS**	III	-	SIKA INDIA LTD	-	N	
				CICO TECHONOLOGIES LTD	-	N	
				FOSROC CHEMICALS (I) PVT LTD	-	N	
				BASF	-	N	
3.	**FALSE CEILING - GLASS REINFORCED GYPSUM SYSTEM, MINERAL FIBRE BOARD SYSTEM, PREPAINTED COIL COATED STEEL SYSTEM**	III	-	SAINT GOBAIN	NEW DELHI	N	
				HUNTER DOUGLOUS	MUMBAI	N	
				TIGER STEEL	PUNE/MUMBAI	N	
				INTERARCH	NOIDA	N	
				LLOYD INSULATION	-	N	
				MG INDUSTRIES	FARIDABAD	N	
				ARM STRONG	NEW DELHI	N	
4.	**PAINT AND PAINTING SYSTEM**	III	-	BERGER	-	N	
				SHALIMAR PAINTS	-	N	
				JENSON AND NICHOLSON	-	N	
				KANSAI NEROLAC	-	N	
				AKZO NOBEL	-	N	
				ASIAN PAINTS	-	N	
5.	**COLOUR COATED SHEET (FOR COIL)**	I	-	UNION STEEL	KOREA	A	
				DONGBU STEEL	KOREA	A	
				BHUSHAN STEEL AND STRIPS LTD.	RAIGAD	A	
				ESSAR STEEL LTD	PUNE	A	
				NATIONAL STEEL AND AGRO	DHAR	A	

Bharat Heavy Electricals Limited PS-MKTG Delhi

C & M Deptt.

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	PROJECT: PATRATU STPP-I (3X800 MW)	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB- SUPPLIER APPROVAL				NTPC DOC NO	
NTPC	PACKAGE: EPC					REV. NO.	0
	MAIN SUPPLIER: BHEL	SUB SYSTEM: CIVIL WORKS				DATE	05.04.2017
	CONTRACT NO.: CS-9585-001-2						

SR. NO.	ITEM	QAP / INSP. CAT	QAP NO.	PROPOSED SUB SUPPLIER	PLACE OF MANUFACTURING	APPROVAL STATUS / CATEGORY	REMARKS
				JSW STEEL COATED PRODUCTS LTD	KAMLESHWAR	A	Formerly JSW ISPAT Steel Ltd
				BHUSHAN STEEL LTD.	SAHIBABAD	A	
				JSW LTD	THANE	A	
				BHUSHAN POWER & STEEL LTD	SAMBALPUR (ODISHA)	A	
				TATA BLUESCOPE STEEL LTD	JAMSHEDPUR	A	*AL-ZN COIL FOR CLADDING
6.	PROFILERS FOR DECKING/ CLADDING SHEETS	I		UNIMET PROFILES LIMITED	DHARUHERA	A	
				MULTICOLOUR STEEL INDIA LIMITED	GURGAON	A	
				ISOLLOYD	SOLAN	A	
				NATIONAL STEEL AND AGRO	DHAR	A	
				ERA BUILD SYS	RUDRAPUR	A	
				TATA BLUE SCOPE	PUNE	A	HINJEWARI WORKS
				TATA BLUE SCOPE	BHIWADI	A	
				PENNAR INDUSTRIES	ISNAPUR	A	FOR DECKING
				PENNAR INDUSTRIES	TARAPUR	A	FOR CLADDING
				METALKRAFT FORMING INDUSTRIES PVT. LTD.	MEDAK (AP)	A	
				BHUSHAN POWER & STEEL LTD	SAMBALPUR (ODISHA)	A	
				ALFA STEEL BUILDING SOLUTIONS	HOSUR	A	
7.	ELECTROFORGED GRATING	II		INDIANA GRATING	PUNE	A	
				PREMIER POWER PRODUCTS (CALCUTTA) PVT LTD	HOWRAH	A	

Bharat Heavy Electricals Limited * PS-MKTG Delhi

C & M Deptt.

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	PROJECT: PATRATU STPP-I (3X800 MW)	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB- SUPPLIER APPROVAL				NTPC DOC NO	
एनटीपीसी NTPC	PACKAGE: EPC					REV. NO.	0
	MAIN SUPPLIER: BHEL	SUB SYSTEM: CIVIL WORKS				DATE	05.04.2017
	CONTRACT NO.: CS-9585-001-2						
SR. NO.	ITEM	QAP / INSP. CAT	QAP NO.	PROPOSED SUB SUPPLIER	PLACE OF MANUFACTURING	APPROVAL STATUS / CATEGORY	REMARKS
				GREATWELD	PUNE	A	
				BHOLA RAM STEELS	PATNA	A	
				ANKIT ELECTROGRATING	RAIPUR	A	
				KANADE ANAND UDYOG	THANE	A	
				SUTTATTI ENTERPRISES	PUNE	A	
				PINAX STEEL INDUSTRIES	PATNA	A	
8.	GI PIPES	III	-	BIS APPROVED SOURCES HAVING VALID BIS LICENCE	-	-	
9.	PVC WATER STOP	III	-	BIS APPROVED SOURCES HAVING VALID BIS LICENCE	-	-	
10.	BITUMEN ASPHALT	III	-	ALL GOVERNMENT REFIINARIES	-	-	
11.	PLASTIC/ PVC PIPES	III	-	BIS APPROVED SOURCES HAVING VALID BIS LICENCE	-	-	
12.	BITUMEN IMPREGNATED FIBER BOARD JOINT FILLER , BITUMEN SEALING COMPOUND	III	-	BIS APPROVED SOURCES HAVING VALID BIS LICENCE	-	-	
13.	CERAMIC / VITRIFIED TILES	III	-	BIS APPROVED SOURCES HAVING VALID BIS LICENCE	-	-	
14.	ACID / ALKALI RESISTANCE TILES, AR BRICKS, AR CEMENT (POTASSIUM SILICATE BASED CEMENT MORTAR, PHENOLIC BASED RESIN CEMENT) AR BITUMASTIC	III	-	CARBORANDUM UNIVERSAL	CHENNAI	N	
				GOOD EARTH MINERALS	MORBI	N	
				PELICAN	BHIWADI	N	
				CAMBRIAN	ALWAR	N	
				KERATECH	VADODARA	N	
				CHAMPION CERAMICS	CHAMPA	N	
				SUNSHINE CERAMICS	CHAMPA	N	
				MAHAKOSHAL POTTRIES	KATNI	N	

Bharat Heavy Electricals Limited PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited Dist-Ramgarh(Jharkhand) C & M Deptt.

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	PROJECT: PATRATU STPP-I (3X800 MW)	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB- SUPPLIER APPROVAL				NTPC DOC NO	
एनटीपीसी NTPC	PACKAGE: EPC					REV. NO.	0
	MAIN SUPPLIER: BHEL	SUB SYSTEM: CIVIL WORKS				DATE	05.04.2017
	CONTRACT NO.: CS-9585-001-2						
SR. NO.	ITEM	QAP / INSP. CAT	QAP NO.	PROPOSED SUB SUPPLIER	PLACE OF MANUFACTURING	APPROVAL STATUS / CATEGORY	REMARKS
				PERFECT ACID WARE	JABALPUR	N	
				BABA BAIDNATH REFRACTORIES	PURULIA	N	
15.	FIRE PROOF DOORS	III	-	NAVAIR INTERNATIONAL LTD.	NEW DELHI	N	Prototype tested from CBRI/CPRI
				SHAKTI MET DOOR	HYDERABAD	N	
				SUPER STEEL	DELHI	N	
				SIGNUM FIRE PROTECTION	NAGPUR	N	
				RADIANT SAFE DOORS	AHMEDABAD	N	
16.	PARTICLE BOARDS, PLYWOOD, MDF	III	-	BIS APPROVED SOURCES HAVING VALID BIS LICENCE	-	-	
17.	ALUMINUM SECTIONS	III	-	HINDALCO	-	N	
				INDALCO	-	N	
				BALCO (VEDANTA)	-	N	
				NALCO	-	N	
				ALOM EXTRUSIONS LTD	-	N	
				JINDAL	-	N	
18.	HIGH SOLID CONTENT LIQUID APPLIED URETHANE BASED ELASTOMERIC MEMBRANE FOR WATER PROOFING	III	-	STP	-	N	
				IWL INDIA LTD	-	N	
				LLOYDS	-	N	
				CICO TECHONOLOGIES LTD	-	N	
				MK PETRO	-	N	
19.	SANITARY ITEMS	III		PARRYWARE	-	N	
				HINDWARE	-	N	
				SEABIRD	-	N	
				ORIENT	-	N	

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C & M Deptt.

G.V. Patra 05/04/17

	PROJECT: PATRATU STPP-I (3X800 MW)	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB- SUPPLIER APPROVAL				NTPC DOC NO	
एनटीपीसी NTPC	PACKAGE: EPC					REV. NO.	0
	MAIN SUPPLIER: BHEL	SUB SYSTEM: CIVIL WORKS				DATE	05.04.2017
	CONTRACT NO.: CS-9585-001-2						
SR. NO.	ITEM	QAP / INSP. CAT	QAP NO.	PROPOSED SUB SUPPLIER	PLACE OF MANUFACTURING	APPROVAL STATUS / CATEGORY	REMARKS
				HINDUSTAN	-	N	
				CERA	-	N	
20.	CP BRASS TAP AND OTHER SANITARY FITTINGS	III	-	GEM	-	N	
				PARKO	-	N	
				JAQUAR	-	N	
				MARC	-	N	
21.	POLYTHENE WATER STORAGE TANKS	III	-	BIS APPROVED SOURCES HAVING VALID BIS LICENCE	-	-	
22.	RCC PIPES	III	-	BIS APPROVED SOURCES HAVING VALID BIS LICENCE	-	-	
23.	STOP LOG GATES, TRASH RACK AND LIFTING BEAM	I		GENERAL MECHANICAL WORKS	BARODA	A	
				TRIVENI	NOIDA	A	
				MACMET	KOLKATA	A	
				PRADEEP STRUCTURES	HOWRAH	A	
				RED FAB	HYDERABAD	A	
				L&T	KANCHIPURAM	A	
				BSBK ENGG	NOIDA	A	
24.	PTFE BEARING / ELASTOMERIC BEARING	III		ALL CURRENT MORTH / RDSO APPROVED VENDORS		-	
25.	FABRIC EXPANSION COMPENSATOR	I		KELD ELLENTOFT INDIA LTD	CHENNAI	A	
				EAGLE BURGMANN KE PRIVATE LTD	CHENNAI	A	
				FRENZELIT EXPANSION JOINT PVT. LTD	BANGALORE	A	
26.	MINERAL WOOL FOR THERMAL	I		ROCKWOOL INDIA LTD.	HYDERABAD	A*	A*: subject to

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05/04/17

	PROJECT: PATRATU STPP-I (3X800 MW)	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB- SUPPLIER APPROVAL				NTPC DOC NO	
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	MAIN SUPPLIER: BHEL	SUB SYSTEM: CIVIL WORKS				DATE	05.04.2017
	CONTRACT NO.: CS-9585-001-2						
SR. NO.	ITEM	QAP / INSP. CAT	QAP NO.	PROPOSED SUB SUPPLIER	PLACE OF MANUFACTURING	APPROVAL STATUS / CATEGORY	REMARKS
	INSULATION			PUNJSTAR INSULATION FIBRE COMPANY	BHILAI	A	carrying out K-value test at CBRI Roorkee / NTPC approved lab.
				LAPINUS	MALANPUR (MP)	A*	
				MINWOOL	RAJANANDGAON	A*	
				LLOYD INSULATION	BHILAI	A*	
				SHREERAM EQUITECH PVT. LTD.	DURG	A	
				GOENKA ROOKWOOL (I) PVT, LTD.	RAIPUR	A	
				U.P. TWIGA	BULENDSHAHAR	A	
27.	**CHIMNEY ELEVATOR***	I		MEKASTER ENGG. & EQPT (P) LTD.,	HALOL, GUJARAT	A	
				ALIKRAFT ENGINEERS PVT. LTD.	SAVIL (VADODARA)	A	
				UNIVERSAL CONSTRUCTION MACHINARY & EQUIPMENTS	PUNE	A	
28.	**GEOTEXTILE**	III		GARWARE WALL ROPES Ltd	PUNE	N	
				TENCATE GEOSYNTHETICS ASIA	MALAYSIA	N	NON WOVEN
29.	**GEOMEMBRANE (HDPE LINER)**	II		D P WIRES PVT. LTD	RATLAM	A	
				CLIMAX SYTHETICS PVT. LTD	VADODARA	A	
				SHIVALIK AGROPOLY	PARWANOO	A	
30.	**CI PIPES**	III	-	BIS APPROVED SOURCES HAVING VALID BIS LICENCE			

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05/04/17

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एनटीपीसी NTPC	PACKAGE: EPC					REV. NO.	0
	MAIN SUPPLIER: BHEL	SUB SYSTEM: CIVIL WORKS				DATE	05.04.2017
	CONTRACT NO.: CS-9585-001-2						
SR. NO.	ITEM	QAP / INSP. CAT	QAP NO.	PROPOSED SUB SUPPLIER	PLACE OF MANUFACTURING	APPROVAL STATUS / CATEGORY	REMARKS
31.	**GALAVANISED STEEL STRUCTURES (FOR TRANSMISION LINE, LATTICE & PIPE)**	I		VIJAY TRANSMISSION LTD	RAIPUR	A	Subject to clearance of Provenness criteria for Transmission Line Structures
				UNITECH POWER TRANSMISSION LTD	NAGPUR	A	
				ASSOCIATED POWER STRUCTURES	VADODARA	A	
				R.S. INFRAPROJECTS PVT. LTD	SURAJPUR	A	
				NEW MODERN TECHNOMECH	MAYURBHANJ (ORRISA)	A	
				GOOD LUCK STEEL TUBES	SIKANDRABAD	A	
				UNIQUE STRUCTURES & TOWERS LTD.	RAIPUR	A	
				VATCO ELEC-POWER PVT. LTD.	NAVIMUMBAI (GALVANISING AT SIGMA GALVANISER NAVI MUMBAI)	A	
				R.S. INFRAPROJECTS PVT. LTD	GHAZIABAD	A	
				ADVANCE STEEL TUBE ,	SAHIBABAD	A	
				SANGAM STRUCTURES LTD.	ALLAHABAD	A	
				RICHARDSON & CRUDDAS (1972) LTD	NAGPUR	A	
32.	**HIGH PERFORMANCE MOISTURE COMPATIBLE CORROSION RESISTANT COATING SYSTEM**	III		CECRI LICENSED SOURCES		-	
33.	**MS PIPES (IS:3589, WELDED PIPES)**	III		BIS APPROVED SOURCES HAVING VALID BIS LICENCE		-	

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05/04/17

	PROJECT: PATRATU STPP-I (3X800 MW)	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB- SUPPLIER APPROVAL				NTPC DOC NO	
एनटीपीसी NTPC	PACKAGE: EPC					REV. NO.	0
	MAIN SUPPLIER: BHEL	SUB SYSTEM: CIVIL WORKS				DATE	05.04.2017
	CONTRACT NO.: CS-9585-001-2						
SR. NO.	ITEM	QAP / INSP. CAT	QAP NO.	PROPOSED SUB SUPPLIER	PLACE OF MANUFACTURING	APPROVAL STATUS / CATEGORY	REMARKS
34.	**Factory Fabricated Steel Structure** (Subject to clearance of Provenness criteria)	I		JSW SEVERFIELD	BELLARY	A	
				CAPACITE STRUCTURES Ltd.	Palghar	A	
				ATMASTCO PVT LTD	DURG	A	
				Corefab Projects Pvt Ltd	Bhilai	A	
				Indiana Gratings Pvt Ltd	PURANDAR	A	Acceptable for Columns & Beams (maximum single piece size up to 15 MT)
				JINDAL STEEL & POWER LTD.	RAIGARH	A	
				JINDAL STEEL & POWER LTD.	Angul	A	
				ALLIANCE INTEGRATED METALIKS LTD	RAJPURA	A	
				MIURA INFTASTRUCTURE LTD.	BHILAI	A	Acceptable upto maximum single piece weight of 30 MT
				BHEL	RANIPET	DR	
35.	**PRE ENGINEERED BUILDINGS**	I		INTERARCH	PANT NAGAR	A	
				DEVASHISH INFRASTRUCTURE PVT. LTD	VADODARA	A	
				EVEREST STEEL	ROORKEE	A	

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G.V Patgar 05/04/17. (B.H.E.L)

ANNEXURE-I

	PROJECT: PATRATU STPP-I (3X800 MW)	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB- SUPPLIER APPROVAL				NTPC DOC NO	
NTPC	PACKAGE: EPC					REV. NO.	0
	MAIN SUPPLIER: BHEL	SUB SYSTEM: CIVIL WORKS				DATE	05.04.2017
	CONTRACT NO.: CS-9585-001-2						
SR. NO.	ITEM	QAP / INSP. CAT	QAP NO.	PROPOSED SUB SUPPLIER	PLACE OF MANUFACTURING	APPROVAL STATUS / CATEGORY	REMARKS

LEGENDS:

1. SYSTEM SUPPLIER/SUB-SUPPLIER APPROVAL STATUS CATEGORY (SHALL BE FILLED BY NTPC)

A – For these items proposed vendor is acceptable to NTPC. To be indicated with letter "A" in the list along with the condition of approval, if any.

DR – For these items "Details required" for NTPC review. To be identified with letter "DR" in the list.

'N' NOTED – For these items vendors are approved by Main Supplier and accepted by NTPC without specific vendor approval from NTPC. To be identified with 'NOTED.'

2. QP/INSPN CATEGORY:

CAT-I : For these items the Quality Plans are approved by NTPC and the final acceptance will be on physical inspection witness by NTPC.

CAT-II : For these items the Quality Plans approved by NTPC. However no physical inspection shall be done by NTPC. The final acceptance by NTPC shall be on the basis review of documents as per approved quality plan.

CAT-III : For these items Main Supplier approves the Quality Plans.

UNITS/ WORKS : Place of manufacturing Place of Main Supplier of multi units/works.

NOTE 1: For the items placed in CAT-III for Civil Works, the review and final acceptance shall be done by NTPC-EIC/ FQA on the basis of MTC / certificate of conformance in line with Indicative FQP / Technical Specifications.

Maidasany
(Ajay Maidasani)
NTPC

Bharat Heavy Electricals Limited
PS-MKTG
Delhi

Patrata Vidyut Utpadan Nigam Ltd.
C & M
Deptt.
Distt. Ramgarh (Jharkhand)

G.V.Rajasekhar 05/04/17.
(G.V.RAJASEKHAR
MANAGER – COMMERCIAL
BHEL – PSWR.

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ANNEXURE-III

FUNCTIONAL GUARANTEES AND LIQUIDATED DAMAGES

FUNCTIONAL GUARANTEES, LIQUIDATED DAMAGES FOR SHORTFALL IN PERFORMANCE AND GUARANTEE TESTS

The term "Performance Guarantees" wherever appears in this Sub-Section shall have the same meaning and shall be synonymous to "Functional Guarantees". Similarly the term "Performance Tests" wherever appears in this Sub-Section shall have the same meaning and shall be synonymous to "Guarantee Test(s)".

The term "BMCR" (Boiler Maximum Continuous Rating) appearing in the Technical Specification shall mean the maximum continuous steam output of Steam Generator (as defined Cl. No. 1.02.00 Sub-section A-02, Part-B) at super heater outlet at rated parameters.

The term "TMCR" (Turbine maximum continuous rating) appearing in the technical specification shall mean 800 MW electrical power output at generator terminals (power at generator terminals as per clause indicated in this sub-section) under rated steam parameters, 0% cycle make-up and 160 mmHg (abs) condenser pressure unless used in conjunction with a different cycle make-up and/or a different condenser pressure and /or a different throttle steam pressure.

1.00.00 PERFORMANCE GUARANTEES

1.00.01 General Requirements

a) The Contractor shall guarantee that the equipment offered shall meet the ratings and performance requirements stipulated for various equipment covered in these specifications.

b) The guaranteed performance parameters furnished by the bidder in his offer, shall be without any tolerance values whatsoever and all margins required for instrument inaccuracies and other uncertainties shall be deemed to have been included in the guaranteed figures.

c) The Contractor shall conduct performance test and demonstrate all the guarantees covered herein, during performance guarantee/acceptance test. The various tests which are to be carried out during performance guarantee/acceptance test are listed in this Sub-section. The guarantee tests shall be conducted by the Contractor at site in presence of Employer on each unit individually.

d) All costs associated with the tests including cost associated with the supply, calibration, installation and removal of the test instrumentation, shall be included in the bid price.

e) It is the responsibility of the contractor to perform the Performance

Guarantee/Acceptance test as specified in this subsection. The performance tests will be performed using only the normal number of Employer supplied operating staff. Contractor, vendor or other subcontractor personnel shall only be used for instructional purposes or data collection. At all times during the Performance Tests the emissions and effluents from the Plant shall not exceed the Guaranteed Emission and Effluent Limits.

f) The Contractor shall make the plant ready for the performance guarantee tests.

g) All instruments required for performance testing shall be of the type and accuracy required by the code and prior to the test, the contractor shall get these instruments calibrated in an independent test Institute approved by the Employer. All test instrumentation required for performance tests shall be supplied by the contractor and shall be retained by him upon satisfactory completion of all such tests at site. All calibration procedures and standards shall be subjected to the approval of the Employer. The protecting tubes, pressure connections and other test connections required for conducting guarantee test shall conform to the relevant codes.

h) Tools and tackles, thermowells (both screwed and welded) instruments/devices including flow devices, matching flanges, impulse piping & valves etc. and any special equipment, required for the successful completion of the tests, shall be provided by the contractor free of cost.

i) The Performance / Acceptance test shall be carried out as per the agreed procedure. The PG test procedure including demonstration tests shall be submitted within 90 days of the date of Notification of Award and finalization of the PG test procedure shall be done within 180 days from the date of Notification of Award. After the conductance of Performance test, the contractor shall submit the test evaluation report of Performance test results to Employer promptly but not later than one months from the date of conductance of Performance test. However, preliminary test reports shall be submitted to the Employer after completing each test run.

The P&G test procedures shall be submitted for equipments/ system & subsystem under Contractor's scope for all Guarantees under category I, II & III as mentioned below, as per latest International codes / standard including correction curves, meeting the specification requirements along with sample calculations & detailed activity plan of preparation (including test instrumentation), conductance and evaluation of Guarantees.

j) The contractor shall submit for Employer's approval the detailed Performance Test procedure containing the following:

a) Object of the test.

b) Various guaranteed parameters & tests as per contract.

c) Method of conductance of test and test code.

d) Duration of test, frequency of readings & number of test runs.

e) Method of calculation.

f) Correction curves.

g) Instrument list consisting of range, accuracy, least count, and location of instruments.

h) Scheme showing measurement points.

i) Sample calculation.

j) Acceptance criteria.

k) Any other information required for conducting the test.

k) In case during performance guarantee tests it is found that the equipment/system has failed to meet the guarantees, the Contractor shall carry out all necessary modifications and/or replacements to make the equipment/system comply with the guaranteed requirements at no extra cost to the Employer and re-conduct the performance guarantee test(s) with Employer's consent. However if the specified performance guarantee(s) are still not met but are achieved within the Acceptable Shortfall Limit specified at clause 1.01.02 of this subsection, Employer will accept the equipment/system/plant after levying liquidated damages as per clause 1.01.02 of this sub-section. If, however, the demonstrated guarantee(s) continue to be more than the stipulated Acceptable Shortfall Limit, even after the above modifications/replacements within ninety (90) days or a reasonable period allowed by the Employer, after the tests have been completed, the Employer will have the right to either of the following:

i) **For Category-I Guarantees**

Reject the equipment/system/plant and recover from the Contractor the payments already made

OR

Accept the equipment/system/plant after levying Liquidated Damages as specified hereunder. The liquidated damages, for shortfall in performance indicated in clause 1.01.02 for this sub-section are on per unit basis and shall be levied separately for each unit, except for the rate indicated for auxiliary power consumption for station auxiliaries which is on station basis. The liquidated damages shall be prorated for the fractional parts of the deficiencies. The performance guarantees coming under this category shall be called `Category - I' Guarantees.

ii) **For Category-II Guarantees**

Reject the equipment/plant/system and recover from the Contractor the payments already made. The performance guarantees under this category shall be called 'Category - II ' Guarantees. Conformance to the performance requirements under Category -II is mandatory.

iii) **For Category-III Guarantees**

Reject the equipment / system/plant & recover from the Contractor the payments already made.

OR

Accept the equipment/system after assessing the deficiency in respect of the various ratings, performance parameters and capabilities and recover from the contract price an amount equivalent to the damages as determined by the EMPLOYER. Such damages shall, however be limited to the cost of replacement of the equipment(s) / system(s) replacement of which shall remove the deficiency so as to achieve the guarantee performance. These parameters/capacities shall be termed as category - III, guarantees.

1.01.00 GUARANTEES UNDER CATEGORY I

Bidder to guarantee auxiliary power consumption for Potable Water pumps drives as specified. Bidder to note that technical loading will be applicable as per the 'Notes' indicated in 'GUARANTEED AUXILIARY POWER CONSUMPTION FIGURES' format enclosed in Vol-III of this technical specification.

a) **Adjustment factor for bid evaluation-**

US $ 2,179/- (US Dollar Two Thousand One Hundred Seventy Nine only) per KW increase in the Auxiliary power consumption from the requirements stipulated in Annexure-III A.

b) **Amount of Liquidated Damages Applicable For Category-I Guarantees.(Please Ref. Notes Below)**

US $ 3,025 /- (US Dollar Three Thousand Twenty Five only) per 1 KW increase in Auxiliary Power Consumption during performance guarantee test from the requirements stipulated in Annexure-III A of this technical specification.

(+) 1.0% of the guaranteed Auxiliary Power Consumption shall be acceptable shortfall with LD.

Notes:-

1. If the contract currency is other than US dollars, then the liquidated damages shall be in equivalent amount in contract currency based on Bill selling exchange rate of State Bank of India prevailing on 08.03.2018.
2. All these liquidated damages for short fall in performance shall be deducted from the contract price as detailed in accompanying General Conditions of Contract (GCC)/ Special Conditions of Contract (SCC).
3. Contractor's aggregate liability to pay liquidated damages for failure to attain the functional guarantee shall not exceed twenty five percent (25%) of the Contract Price.

1.02.00 GUARANTEE UNDER CATEGORY –II

NIL

1.03.00 GUARANTEE UNDER CATEGORY –III

1. PRE-TREATMENT PLANT:-

A) CLARIFICATION PLANT

1. Each clarifier unit for PT-ACW & Potable system, PT-DM & PT-RO system shall be guaranteed for design effluent capacity meeting the effluent quality as mentioned below.
2. Outlet water from clarifiers shall be guaranteed for the following:

Organic Matter	Less than 0.05 mg/litre (see note below)
Iron Content	Less than 0.3 mg/litre
Turbidity	Less than 10 NTU

Note: Organic matter shall be tested as per $KMnO_4$ method.

B) FILTRATION PLANT

1. Each Gravity filter for PT-DM system, PT-RO DM, PT-Potable system shall be guaranteed for design capacity meeting the effluent quality as mentioned below with one (1) backwash and air scouring in not less than 24 hours or more and backwash water requirement not to exceed 2% of the water treated between two successive backwashes.
2. Turbidity at outlet of each Gravity filter system shall not exceed 2 NTU with inlet turbidity of 10 NTU.

C) TUBE SETTLER/LAMELLA CLARIFIER

1. Lamella Clarifier shall be guaranteed for design effluent capacity meeting the effluent quality as mentioned below.
2. Effluent quality at the outlet of Tube settler/Lamella Clarifier shall be guaranteed for the following:

Effluent Turbidity	:	10 NTU at design flow
Effluent Oil & grease	:	5 ppm (maximum)

D) COAL SLURRY SETTLING POND (CSSP)

1. Guaranteed effluent TSS at the outlet of each Coal Slurry Settling Pond during storm water (design) flow condition of 1000 Cu.M/hr shall be 100 ppm (max.) and particles of size 50 microns & above shall be arrested in the CSSP. Testing shall be carried out to demonstrate the above mentioned Guarantees at site under P&G test.

2. CRANE, MONORAIL,HOIST ETC:-

The parameters/capabilities to be demonstrated for following systems/ equipments shall be:

(i) **EOT Cranes :** Over load tests, travel and hoist speed checks as per relevant Indian standards IS (latest edition).

(ii) **HOT Cranes, Monorails etc.:** Over load test, Travel and speed checks, functional and performance tests as per relevant Indian standards IS (latest edition).

3. NOISE:-

Noise

All the plant, equipment and systems covered under this specification shall perform continuously without exceeding the noise level over the entire range of output and operating frequency specified in General Technical Requirement, Part-C Section-VI of the technical specifications.

Noise level measurement shall be carried out using applicable and internationally acceptable standards. The measurement shall be carried out with a calibrated integrating sound level meter meeting the requirement of IEC 651 or BS 5969 or IS 9779.

Sound pressure shall be measured all around the equipment at a distance of 1.0 m horizontally from the nearest surface of any equipment/ machine and at a height of 1.5 m above the floor level in elevation.

A minimum of 6 points around each equipment shall be covered for measurement. Additional measurement points shall be considered based on the applicable standards and the size of the equipment. The measurement shall be done with slow response on the A - weighting scale. The average of A-weighted sound pressure level measurements expressed in decibels to a reference of 0.0002 micro bar shall not exceed the guaranteed value. Corrections for background noise shall be considered in line with the applicable standards. All the necessary data for determining these corrections, in line with the applicable standards, shall be collected during the tests.

ANNEXURE-IIIA

ESTIMATED AUXILIARY POWER CONSUMPTION FIGURES

S.NO.	DESCRIPTION OF EQUIPMENT	NO OF EQUIPMENT		TOTAL GUARANTEED POWER CONSUMPTION FOR PRE TREATMENT PLANT (CONTINUOUS DRIVES) (IN KW)	DUTY FACTOR	TOTAL KW
		WORKING	STANDBY			
1.	Potable water pumps (Plant)	1	1	5.5	1	5.5
2.	Potable water pumps (Colony)	1	1	15.0	1	15.0
				TOTAL (KW)		**20.5**

ANNEXURE IV

DRAWING/ DOCUMENTS REQUIREMENT & DISTRIBUTION SCHEDULE

After award of LOI, The drawing documents listed in MDL are minimum drawing/documents, which shall be submitted by the bidder for BHEL and Customer approval. However any additional drawing/document if found necessary for completion of the engineering, the same shall be submitted by bidder without any commercial & delivery implication to BHEL.

The bidder has to submit the revised drawing/document along with the compliance sheet indicating enumerate reply to all BHEL and customer comments or observations. Without compliance sheet the submission of the drawings/documents will not be considered and the delay on this account will be solely on bidder's side only. Bidder to comply with the observations of the BHEL and CUSTOMER without price & delivery implication.

Every revised submission incorporating BHEL/Customer comments shall be resubmitted within 7 day by bidder.

Bidder to further note that the submitted drawings/revised drwaing, should be complete in all respects. Any incomplete drawing submitted shall be treated as non-submission with delays attributable to bidder's account. For any clarification/ discussion required to complete the drawings, the bidder shall himself depute his personal to BHEL's / Customer's office for across the table discussions/ finalizations/ submissions of drawings.

- (a) List and schedule of drawings/documents to be submitted after award of contract shall be as per MDL.

- Bidder to note that drawings/documents submission shall be through web based Document Management System. Bidder would be provided access to the DMS for drawings/documents approval and adequate training for the same. Detailed methodology would be finalized during the kick-off meeting. Bidder to ensure following at their end.
  - Internet explorer version – Minimum Internet Explorer 7
  - Internet speed – 2 mbps (Minimum preferred)
  - Pop ups from our external DMS IP (124.124.36.198) should not be blocked
  - Vendor's internal proxy setting should not block DMS application's link
    - (http://124.124.36.198/wrenchwebaccess/login.aspx)

  - DMS user manuals to be used by BHEL PEM vendors for uploading, viewing, revising, commenting and tracking documents on PEM's DMS have been uploaded on PEM internet website (www.bhelpem.com) under the Vendor session.
  - For quick access bidder may refer the link http://bhelpem.com/DMSManuals/DMSManuals.html

- Bidder shall submit soft copy/hard copy/CD ROMs of all the finally approved drawings and O&M Manuals as required by Customer/Customer consultant/BHEL-site/BHEL-PEM. The exact number of hard copies/CD ROMs of these documents to be submitted shall be notified to the bidder at the time of detailed engineering and bidder shall submit the same without any commercial/delivery implications to BHEL/Customer.

- All the drawing documents along with the O&M manual (of all the revisions) are necessarily to be submitted in soft copies in addition to hard copies.

- Bidder to submit soft copies of all the drawing and document along with quality plans for BHEL review and approval.

- Editable copy of all the drawings and documents shall be provided.

- The date of submission of drawing documents shall be considered as the date of submission of hard and soft copes whichever is later.

- All the drawings shall be prepared on computer auto cad and other documents (like datasheet etc.) on MS office software. Bidder not complying to the requirement shall not be considered. For the execution of the contract regular meeting (generally once in 15 days or as per project requirement) is required.

- Vendor to come for meeting with the concerned dealing persons as per BHEL or customer requirement in a short notice.

- Bidder to submit instrument schedule, cable schedule and valve schedule in MS- Excel format during detailed engineering.

- Bidder to also furnish the auto cad copy/MS-Excel/MS-word (as applicable) of the following documents after award of contract. However any other auto cad copy/MS-Excel/MS-word of any other document as per the insistence of BHEL and customer will also be submitted by the bidder without any delivery and commercial implication to BHEL and customer.

  - P&IDs.
  - Equipment lay out of PT Plant.
  - Equipment Cable tray layout of PT Plant.
  - Civil assignment drawings.
  - Piping lay out drawing of PT Plant.

Other requirements

- Engineering for this project is to be carried out in Integrated Intelligent Engineering environment at BHEL end. The engineering platform on which BHEL is doing the project is based on Smart Plant Suite. This is being done to have automated interface checking and thereby minimising rework at site. The engineering for packages placed in TG Hall will essentially be done using Intelligent P&ID, Intelligent Electrical, Intelligent Instrumentation and 3D modelling. For other BOPs i.e. those outside TG hall, though the same level of integration is preferable but 3D modelling is necessarily to be done and review model in compatible format is to be provided to BHEL on stages to be agreed.

  Hence in line with above, bidder is required to prepare PIDs, Electrical drawings and all layout drawings using intelligent software with capability for transfer of data to and from corresponding Software being used by PEM.

- The data of models of facilities will be made available to BHEL as per the BHEL schedule for importing into BHEL model for interface checking and raising of integrated plant model. Layout and PID/electrical drawings will be extracted from the model.

- Standard write up on format compatibility of the BHEL's engineering platform for this project is attached as File formats supported by SPPID, SPI, SPEL & SP3D (Refer Section-D1).

- **<u>e-Learning Package/Module:</u>**

  e-learning packages shall be supplied for the equipment / system for the complete pre-treatment plant along with associated electrical and C&I system. Bidder to refer Section-D1 for detail.

- Data/Reports other than listed drawings/documents will also be made available to BHEL as and when required for import into BHEL model.

- Successful bidder shall furnish detailed erection manual for each of the equipment as well as complete system supplied under this contract at least 3 months before the scheduled erection of the concerned equipment / component or along with supply of concerned equipment / component whichever is earlier.

- Document approval by customer under Approval category or information category shall not absolve the vendor of their contractual obligations of completing the work as per specification requirement. Any deviation from specified requirement shall be reported by the vendor in writing and require written approval. Unless any change in specified requirement has been brought out by the vendor during detail engineering in writing while submitting the document to customer for approval, approved document (with implicit deviation) will not be cited as a reason for not following the specification requirement.

- In case vendor submits revised drawing after approval of the corresponding drawing, any delay in approval of revised drawing shall be to vendor's account and shall not be used as a reason for extension in contract completion. However, in case changes are necessitated due to any constraints at customer end, delay in review/ approval of such revised drawing beyond one month will be to customer's account.

	MASTER DRAWING LIST (MDL)			
S.No	**Vendor Drawing No**	**NTPC Drawing No**	**Drawing Title**	**No. Of Weeks for Document Submission After Placing LOI/LOA**
1.	PE-V0-434-158-A001	9585-001-136-PVM-L-259	P & I Diagram for Pre-Treatment Plant	4
2.	PE-V0-434-158-A002	9585-001-136-PVM-U-260	Process Sizing Calculation for PT Plant	4
3.	PE-V0-434-158-A005	9585-001-136-PVM-B-261	G.A of Filter House, Filter Water Resrvoir & Pump House	10
4.	PE-V0-434-158-A006	9585-001-136-PVM-F-262	Composite Plant Layout for Pre-Treatment Plant System	4
5.	PE-V0-434-158-A007	9585-001-136-PVM-L-263	Hydraulic Flow Diagram for Pre-Treatment Plant	4
6.	PE-V0-434-158-A008	9585-001-136-PVM-U-264	Hydraulic Calculation for Pre-Treatment Plant	4
7.	PE-V0-434-158-A011	9585-001-136-PVM-H-265	Valve schedule for PT Plant	12
8.	PE-V0-434-158-A012	9585-001-136-PVM-U-266	Pressure Drop calculation for PT	4
9.	PE-V0-434-158-A015	9585-001-136-PVM-B-267	G.A of Inlet Chamber for PT- DM System (Valve Chamber, Parshall Flume, Stilling Chamber, Inlet Chamber)	10
10.	PE-V0-434-158-A016	9585-001-136-PVM-B-268	G.A of Sludge Sump & Pump House	10
11.	PE-V0-434-158-A017	9585-001-136-PVM-B-269	G.A of Filter Backwash Pit & Pump House	10
12.	PE-V0-434-158-A018	9585-001-136-PVM-B-270	G.A of Chemical House including Overhead Tank (Top of Chemical House)	10
13.	PE-V0-434-158-A019	9585-001-136-PVM-B-271	G.A of Inlet Chamber for PT- CW System (Valve Chamber, Parshall Flume, Stilling Chamber, Inlet Chamber)	10
14.	PE-V0-434-158-A020	9585-001-136-PVC-U-272	Basic Civil Design criteria	4
15.	PE-V0-434-158-A021	9585-001-136-PVI-G-273	I/O LIST FOR PT PLANT AREA	10
16.	PE-V0-434-158-A022	9585-001-136-PVM-B-274	G.A of Reactor Clarifier for PT-CW and DM System including Datasheet	10
17.	PE-V0-434-158-A023	9585-001-136-PVC-B-275	Architectural details of filter house for PT Plant	12
18.	PE-V0-434-158-A024	9585-001-136-PVC-B-276	Architectural details of ground floor plan, section & elevation, terrace plan etc. of Chemical house (two storied) for PTP	12
19.	PE-V0-434-158-A026	9585-001-136-QVM-Q-386	MQP for Reator Clarifier	10
20.	PE-V0-434-158-A028	9585-001-136-PVC-B-277	Civil GA, Foundation & super structure details of Cascade Aerator, Stilling Chamber, Parshall Flume & Inlet Chamber for PT- DM System	12
21.	PE-V0-434-158-A029	9585-001-136-PVC-B-278	Civil GA of Reactor Clarifier for PT-DM System	12

22.	PE-V0-434-158-A030	9585-001-136-PVC-B-279	RCC details of Reactor Clarifier for PT-DM System	12
23.	PE-V0-434-158-A032	9585-001-136-PVC-B-280	CIVIL GA & RCC DETAIL OF BYPASS CHANNEL & INTERCONNECTING CHANNEL OF HRSCC FOR PT-CW TO RGSF & INTERCONNECTING CHANNEL FOR HRSCC FOR PT-DM TO RGSF	12
24.	PE-V0-434-158-A033	9585-001-136-PVC-B-281	Civil GA of Gravity Filter House, filtered water reservoir, sump & pump house for PTP	12
25.	PE-V0-434-158-A034	9585-001-136-PVC-B-282	RCC details for Gravity Filter House, filtered water reservoir, sump & pump house for PTP	12
26.	PE-V0-434-158-A035	9585-001-136-PVC-B-283	Civil GA & R/F details of foundation, columns and plinth beams of Chemical House	12
27.	PE-V0-434-158-A038	9585-001-136-PVC-B-284	Civil GA & R/F details of first floor tie beam, roof beam, slab of Chemi,EPC DM&CWT PEM",Water Treatment Plant_sys"	12
28.	PE-V0-434-158-A040	9585-001-136-PVC-B-285	Civil GA & R/F details of water storage tank above Chemical House	12
29.	PE-V0-434-158-A042	9585-001-136-PVC-B-286	Civil GA of Backwash water collection tank, inlet chamber, Filter backwash Sump & Pump House	12
30.	PE-V0-434-158-A043	9585-001-136-PVC-B-287	RCC detail of Backwash water collection tank, inlet chamber, Filter backwash Sump	12
31.	PE-V0-434-158-A046	9585-001-136-PVC-B-288	Civil GA of Sludge pit, sump & pump house	12
32.	PE-V0-434-158-A047	9585-001-136-PVC-B-289	RCC detail of Sludge pit, sump & pump house	12
33.	PE-V0-434-158-A050	9585-001-136-PVC-U-290	Civil Design Calculation of Cascade Aerator, Stilling Chamber, Parshall Flume & Inlet Chamber for PT- DM System	12
34.	PE-V0-434-158-A051	9585-001-136-PVC-U-291	Civil Design Calculation of Reactor Clarifier for PT-DM System	12
35.	PE-V0-434-158-A052	9585-001-136-PVC-U-292	CIVIL DESIGN CALCULATION OF BYPASS CHANNEL & INTERCONNECTING CHANNEL OF HRSCC FOR PT-CW TO RGSF & INTERCONNECTING CHANNEL FOR HRSCC FOR PT-DM TO RGSF	12
36.	PE-V0-434-158-A053	9585-001-136-PVC-U-293	Civil design calculation for Gravity Filter House, filtered water reservoir, sump & pump house of PT & DM system.	12
37.	PE-V0-434-158-A054	9585-001-136-PVC-U-294	Civil Design Calculation of Chemical house (two storied) for PT-CW system.	12
38.	PE-V0-434-158-A056	9585-001-136-PVC-U-295	Civil Design Calculation of Backwash water collection tank, inlet chamber, Filter backwash Sump & Pump House	12
39.	PE-V0-434-158-A057	9585-001-136-PVC-U-296	Civil Design Calculation of Sludge pit, sump & pump house	12
40.	PE-V0-434-158-A058	9585-001-136-QVI-Q-362	TYPE TEST REPORT OF FLOW ELEMENT (CALIBRATION)	10

41.	PE-V0-434-158-A059	9585-001-136-PVI-H-297	INSTRUMENT SCHEDULE FOR PT PLANT AREA(INDICATING RANGE, SET POINT, ENGG UNIT ETC)	12
42.	PE-V0-434-158-A060	9585-001-136-PVM-H-298	Painting Schedule	12
43.	PE-V0-434-158-A062	9585-001-136-PVM-H-299	Pipe Schedule for PT Plant	10
44.	PE-V0-434-158-A063	9585-001-136-PVM-L-300	Civil GA, Foundation & Super structure details of Cascade Aerator, Stilling Chamber, Parshall Flume & Inlet Chamber for PT- CW System	12
45.	PE-V0-434-158-A065	9585-001-136-PVM-L-301	Civil GA of Reactor Clarifier for PT-CW System Connecting chanel for clarifiers	12
46.	PE-V0-434-158-A066	9585-001-136-PVM-L-302	RCC details of Reactor Clarifier for PT-CW System Connecting chanel for clarifiers	12
47.	PE-V0-434-158-A069	9585-001-136-PVC-U-303	Civil Design Calculation of Cascade Aerator, Stilling Chamber, Parshall Flume & Inlet Chamber for PT- CW System	12
48.	PE-V0-434-158-A070	9585-001-136-PVC-U-304	Civil Design Calculation of Reactor Clarifier for PT-CW System Connecting chanel for clarifiers	12
49.	PE-V0-434-158-A072	9585-001-136-PVI-G-305	LIST OF ALARM FOR PT PLANT AREA	10
50.	PE-V0-434-158-A073	9585-001-136-PVM-W-306	System Description & Control Write up	4
51.	PE-V0-434-158-A074	9585-001-136-PVM-B-307	GA OF FLASH MIXER, FLOCCULATION TANK AND TUBE PLATE SETTLER	10
52.	PE-V0-434-158-A075	9585-001-136-PVM-B-308	General Arrangement & Civil Block out details of Sluice Gate	10
53.	PE-V0-434-158-A076	9585-001-136-QVM-Q-385	MQP for Sluice Gate	10
54.	PE-V0-434-158-A077	9585-001-136-PVM-Y-309	Datasheet for Platform type weighing scale	10
55.	PE-V0-434-158-A078	9585-001-136-PVM-L-310	Datasheet and GA of Ball Valves for PTP	10
56.	PE-V0-434-158-A079	9585-001-136-PVM-L-311	Datasheet and G.A of Air Blower	10
57.	PE-V0-434-158-A080	9585-001-136-QVM-Q-378	MQP for Dual Plate Check Valves	10
58.	PE-V0-434-158-A081	9585-001-136-QVM-Q-379	MQP for Ball Valves	10
59.	PE-V0-434-158-A082	9585-001-136-QVM-Q-380	MQP for Butterfly Valves	10
60.	PE-V0-434-158-A083	9585-001-136-QVM-Q-381	MQP for Gate/ Globe/ Check Valves	10
61.	PE-V0-434-158-A084	9585-001-136-QVM-Q-382	MQP for Diaphragm Valve	10
62.	PE-V0-434-158-A085	9585-001-136-QVM-Q-383	MQP for Air Blower (Lobe Type)	10
63.	PE-V0-434-158-A086	9585-001-136-QVM-Q-384	MQP for NRV Flap Type	10
64.	PE-V0-434-158-A088	9585-001-136-PVM-L-312	DATASHEET & WIRING DIAGRAM OF ELECTRICAL ACTUATOR	10
65.	PE-V0-434-158-A089	9585-001-136-PVI-B-313	INSTRUMENTS HOOK UP DRAWINGS (PT PLANT AREA)	10
66.	PE-V0-434-158-A090	9585-001-136-PVM-B-314	G.A and datasheet of Tank Agitator Assembly	10

67.	PE-V0-434-158-A091	9585-001-136-PVM-Y-315	Datasheet for Strainers	10
68.	PE-V0-434-158-A092	9585-001-136-PVM-B-316	GA AND DATASHEET OF HORIZONTAL CENTRIFUGAL PUMPS WITH MOTOR	10
69.	PE-V0-434-158-A093	9585-001-136-PVM-Y-317	Datasheet for header isolation valve (PT)	10
70.	PE-V0-434-158-A094	9585-001-136-PVM-Y-318	Datasheet for Safety shower and Emergency KIT B	10
71.	PE-V0-434-158-A097	9585-001-136-QVM-Q-365	MQP for MS Pipes	10
72.	PE-V0-434-158-A098	9585-001-136-QVM-Q-366	MQP for SS Pipes	10
73.	PE-V0-434-158-A099	9585-001-136-QVM-Q-367	MQP for CI/ DI Pipes & Fittings	10
74.	PE-V0-434-158-A100	9585-001-136-QVM-Q-368	MQP for Tube Settler Media	10
75.	PE-V0-434-158-A101	9585-001-136-QVM-Q-369	MQP for Pressure Vessel/ Atmospheric Storage Tanks	10
76.	PE-V0-434-158-A102	9585-001-136-QVM-Q-370	MQP for Metering Pump (Diaphragm Type)	10
77.	PE-V0-434-158-A103	9585-001-136-QVM-Q-371	MQP for Strainer Y Type	10
78.	PE-V0-434-158-A104	9585-001-136-QVM-Q-372	MQP for Agitator/ Mixer	10
79.	PE-V0-434-158-A107	9585-001-136-QVI-Q-373	MQP for Control Valve (Butterfly Type)	10
80.	PE-V0-434-158-A108	9585-001-136-QVI-Q-374	MQP for Electrical Actuator	10
81.	PE-V0-434-158-A116	9585-001-136-QVM-Q-375	MQP for Centrifugal Pumps (Horizontal & Vertical)	10
82.	PE-V0-434-158-A117	9585-001-136-QVM-Q-376	MQP for Vertical Wet Pit Turbine Pump	10
83.	PE-V0-434-158-A118	9585-001-136-QVM-Q-377	MQP for Drainage Pump (Submersible type)	10
84.	PE-V0-434-158-A119	9585-001-136-PVI-Y-319	LCP OF REACTOR CLARIFIER FOR PT-CW	10
85.	PE-V0-434-158-A120	9585-001-136-PVI-Y-320	LCP OF REACTOR CLARIFIER FOR PT-DM	10
86.	PE-V0-434-158-A121	9585-001-136-PVI-H-321	INTERCONNECTION DIAGRAM AND CABLE SCHEDULE FOR PT PLANT AREA	10
87.	PE-V0-434-158-A122	9585-001-136-PVM-B-322	GA Drawing & Calculation of Electrical Hoist	10
88.	PE-V0-434-158-A123	9585-001-136-PVM-F-323	Piping Layout for PT	10
89.	PE-V0-434-158-A124	9585-001-136-PVM-X-388	Operation & Maintenance Manual	24
90.	PE-V0-434-158-A125	9585-001-136-QVM-Q-364	MQP for Electrical Hoist	10
91.	PE-V0-434-158-A127	9585-001-136-PVE-H-324	Electrical Load List	10
92.	PE-V0-434-158-A128	9585-001-136-PVI-Y-325	DATA SHEET FOR LOCAL GAUGES	10
93.	PE-V0-434-158-A130	9585-001-136-PVI-Y-326	DATA SHEET FOR FLOW ELEMENT ALONG WITH ORIFICE CALC.	10
94.	PE-V0-434-158-A131	9585-001-136-PVI-Y-327	TECHNICAL DATA SHEET FOR FLOW TRANSMITTER	10
95.	PE-V0-434-158-A132	9585-001-136-PVI-Y-328	DATA SHEET FOR HAND HELD CALIBRATOR	10
96.	PE-V0-434-158-A133	9585-001-136-PVI-Y-329	DATA SHEET FOR JUNCTION BOX	10

97.	PE-V0-434-158-A134	9585-001-136-PVI-Y-330	DATA SHEET FOR PRESSURE TRANSMITTER	10
98.	PE-V0-434-158-A136	9585-001-136-PVI-Y-331	DATA SHEET FOR LEVEL TRANSMITTER FOR PT PLANT	10
99.	PE-V0-434-158-A138	9585-001-136-QVI-Q-360	TYPE TEST REPORT OF ELECTRONIC TRANSMITTER	10
100.	PE-V0-434-158-A142	9585-001-136-QVE-Q-361	TYPE TEST REPORT OF JUNCTION BOX (DEGREE OF PROTECTION)	10
101.	PE-V0-434-158-A143	9585-001-136-PVM-F-332	Layout and details of interconnecting pathways and paving for all facilities	10
102.	PE-V0-434-158-A144	9585-001-136-PVE-F-333	CABLE TRAY LAYOUT OF WATER PRETREATMENT PLANT	10
103.	PE-V0-434-158-A145	9585-001-136-PVI-G-334	DRIVE LIST FOR PTP (DRIVES CONTROLLED FROM DDCMIS)	10
104.	PE-V0-434-158-A147	9585-001-136-PVM-W-387	PG TEST PROCEDURE FOR PT PLANT	20
105.	PE-V0-434-158-A148	9585-001-136-PVI-L-335	CONTROL SCHEMS FOR PT PLANT	12
106.	PE-V0-434-158-A149	9585-001-136-PVM-L-336	STEP LIST FOR PT PLANT	10
107.	PE-V0-434-158-A150	9585-001-136-PVI-Y-337	DATASHEET FOR INSTRUMENT CABLE	10
108.	PE-V0-434-158-A151	9585-001-136-PVM-B-338	GA OF SLUDGE THICKNER	10
109.	PE-V0-434-158-A152	9585-001-136-PVM-B-339	GA OF SUPERNATENT COLLECTION SUMP	10
110.	PE-V0-434-158-A153	9585-001-136-PVM-B-340	GA OF THICKENED WASTE SUMP	10
111.	PE-V0-434-158-A154	9585-001-136-PVC-B-341	CIVIL GA OF THICKENED SUMP & PUMP HOUSE.	12
112.	PE-V0-434-158-A155	9585-001-136-PVC-U-342	CIVIL DESIGN CALCULATIONS OF THICKENED WASTE SUMP.	12
113.	PE-V0-434-158-A156	9585-001-136-PVC-B-343	CIVIL GA & RCC DETAIL OF THICKENER SUERNATANT COLLECTION SUMP & PUMP HOUSE	12
114.	PE-V0-434-158-A158	9585-001-136-PVC-U-344	CIVIL DESIGN CALCULATIONS OF SUERNATANT COLLECTION SUMP & PUMP HOUSE	12
115.	PE-V0-434-158-A159	9585-001-136-PVC-B-345	CIVIL GA OF THICKENER	12
116.	PE-V0-434-158-A160	9585-001-136-PVC-B-346	REINF. DETAIL OF THICKENER	12
117.	PE-V0-434-158-A161	9585-001-136-PVC-U-347	CIVIL DESIGN CALCULATIONS OF THICKENER	12
118.	PE-V0-434-158-A162	9585-001-136-PVM-B-348	GA OF BYPASS CHANNEL & INTERCONNECTING CHANNEL OF HRSCC FOR PT-CW TO RGSF & INTERCONNECTING CHANNEL FOR HRSCC FOR PT-DM TO RGSF	10
119.	PE-V0-434-158-A163	9585-001-136-QVM-Q-363	QUALITY PLAN FOR SLUDGE THICKENER WITH DRIVE HEAD	10
120.	PE-V0-434-158-A164	9585-001-136-PVM-B-349	GA AND DATASHEET OF VERTICAL CENTRIFUGAL PUMPS WITH MOTOR	10
121.	PE-V0-434-158-A165	9585-001-136-PVM-B-350	GA AND DATASHEET OF VERTICAL SCREW PUMPS WITH MOTOR	10
122.	PE-V0-434-158-A166	9585-001-136-PVM-B-351	GA, CROSS SECTION, PERFORMANCE CURVE AND DATASHEET OF DOSING PUMPS	10

			WITH MOTOR FOR PRE-TREATMENT PLANT	
123.	PE-V0-434-158-A167	9585-001-136-PVM-Y-352	DATASHEET AND GA DRAWING OF DIAPHRAGM VALVES FOR PTP	10
124.	PE-V0-434-158-A168	9585-001-136-PVM-Y-353	DATASHEET AND GA DRAWING OF BUTTERFLY VALVES FOR PTP	10
125.	PE-V0-434-158-A169	9585-001-136-PVM-Y-354	DATASHEET AND GA DRAWING OF NRV/CHECK VALVES FOR PTP	10
126.	PE-V0-434-158-A170	9585-001-136-PVM-Y-355	DATASHEET AND GA DRAWING OF GATE VALVES FOR PTP	10
127.	PE-V0-434-158-A171	9585-001-136-PVM-Y-356	DATASHEET AND GA DRAWING OF PLUG VALVES FOR PTP	10
128.	PE-V0-434-158-A172	9585-001-136-PVM-Y-357	DATA SHEET AND GA DRAWING FOR NON METTALIC VALVE (CPVC) FOR PTP	10
129.	PE-V0-434-158-A173	9585-001-136-PVM-B-358	GA AND DATASHEET OF PP FILTER NOZZLES (GRAVITY FILTER)	10
130.	PE-V0-434-158-A174	9585-001-136-PVI-H-359	CABLE SCHEDULE	10

DRAWING/DOCUMENTS DISTRIBUTION SCHEDULE

S.No	Description of Drgs/Docs	No of Prints	No of CD ROMs/DVDs/Portable Hard Disk
1	Drawings, Data sheets, Design calculations, Purchase specifications and other documents		
	First submission and submission with major changes		
	▪ Layout (A0&A1 sizes)	4	-
	▪ Other Drawings/Documents (A0&A1 sizes)	2	-
	▪ P&ID (All sizes)	4	-
	a) Final drawings/documents (Directly to site)	6	2
	b) "As Built" Drawing/Documents (Directly to site)	6	2
	c) Analysis reports of Equipments / piping /structures components/system employing software packages as detailed in the specifications.	2	2
2	Erection Manual (Directly to site)	4 sets	2
3	Operation & Maintenance manual i) First Submission	1 set	--
	ii) Final Submission (Directly to site)	4 sets	2
4	Plant Hand Book i) First Submission	1	1
5	Commissioning and Performance Test Procedure manual i) First Submission	1 set	--
	ii) Final Submission (Directly to site)	4 sets	2

S.No	Description of Drgs/Docs	No of Prints	No of CD ROMs/DVDs/Portable Hard Disk
6	Performance and Functional Guarantee Test Report i) First Submission	2 sets	--
	ii) Approved Copies (Direct to Site)	4 sets	2
7	Project Completion Report (Directly to site)	6 sets	2
8	QA programme including Organisation for implementation and QA system manual(with revisions)	1	--
9	Vendor details in respect of proposed vendors including contractor's evaluation report.	2	--
10	Manufacturing QPs, Field QPs, Field welding schedules and their reference document like test procedures, WPS, POR etc i) For review/comment	1	--
	ii) Approved final copies of Field QPs, Field welding schedules and their reference document like test procedures, WPS, POR etc (Direct to Site)	4	2
11	Welding Manual, Heat Treatment Manuals, Storage & preservation manuals i) For review/comment	1 set	--
	ii) Approved copies (Direct to Site)	4 sets	2
12	QA Documentation Package for items / equipment manufactured and despatched to site	2 sets	2
13	QA Documentation Package for field activities on equipment/systems at site	2 sets	2

Note:

- Quantity of prints may change during detailed engineering stage based on BHEL / Customer requirement. However the same will be adhered by the bidder without any delivery/commercial implication to BHEL.
- All the drawing documents along with the O&M manual (of all the revisions) are necessarily to be submitted in soft copies in addition to hard copies.
- Bidder to submit soft copies of all the drawing and document along with quality plans for BHEL review and approval.
- The date of submission of drawing documents shall be considered as the date of submission of hard and soft copes whichever is later.
- All the drawings shall be prepared on computer auto cad and other documents (like datasheet etc.) on MS office software. Bidder not complying to the requirement shall not be considered. For the execution of the contract regular meeting (generally once in 15 days or as per project requirement) is required.
- Bidder has to come for meeting with the concerned dealing persons as per BHEL or customer requirement in a short notice.
- Bidder to submit instrument schedule, cable schedule and valve schedule in MS- Excel format during detailed engineering.
- Bidder to also furnish the auto cad copy / MS-word (as applicable)/MS-Excel (as applicable) of the following documents after award of contract. However any other auto cad copy/MS-Excel/MS-word of any other document as per the insistence of BHEL / customer will also be submitted by the bidder without any delivery/commercial implication to BHEL.

    - P&IDs.
    - Equipment lay out of the PT Plant area.
    - Equipment Cable tray layout for PT Plant area
    - Equipment earthing layout PT Plant area
    - Civil scope drawings.
    - Piping lay out drawing for PT Plant area and yard piping layout.
    - Valve schedule.
    - Instrument schedule.
    - Any Other Dwg/Docs as required.

ANNEXURE-V

MANDATORY SPARES

I - MECHANICAL

1) CLARIFIERS : PT-ACW, PT-DM System

Sl. No.	Name of Items	Unit	Qty
1)	Turbine drive motor	Set	1
2)	Rake (Scrapper) drive motor	Set	1
3)	Turbine drive shaft assembly	Set	1
4)	Rake (Scrapper) drive shaft assembly	Set	1
5)	Oil seal for gear box	Set	4
6)	Worm wheel	Set	1
7)	Worm shaft	Set	1
8)	All Bearings required for motors, Turbine drive, and Rack drive	Set	1
Note: One set consists of quantity required for complete replacement for one clarifier or motor as the case may be			
2) Lime Slurry Transfer Pumps, Lime Dosing Pumps			
1)	Lime Dosing Pump Unit	No	1
2)	Lime Slurry Transfer Pump Unit	No	1
3)	Coupling between Pump & motor, bushes, pins with all fasteners & coupling Guards (for each type of pump)	Set	1
4)	Gland , Packing & Gland Assembly	Set	1
Note : One set consists of quantity required for complete replacement for one pump			
3) Alum Dosing Pumps : PT – ACW , PT – DM System, LET (for tube settlers)			
1)	Alum Dosing Pump Unit (for each system)	No	1
Note : One set consists of quantity required for complete replacement for one pump			

5) Vertical Sump Pumps – Sludge disposal pumps, Backwash Water pumps (Filters)

Sl. No.	Name of Items	Unit	QUANTITY
1)	Complete Casing including suction (if applicable) bell	Set	1
2)	Impeller	Set	1
3)	Wearing rings – Impeller (if applicable)	Set	2
4)	Wearing rings – Casing (if applicable)	Set	2
5)	Impeller Shaft, line shaft and head shaft	Set	1
6)	Shaft Sleeves	Set	2
7)	Stuffing box	Set	1
8)	Coupling between Pump & motor, bushes, pins with all fasteners & coupling Guards.	Set	1
9)	Line Shaft Couplings (if applicable)	Set	1
10)	Impeller, Line and Head shaft bearings (as applicable)	Set	1
11)	Gland , Packing & Gland Assembly	Set	1

Sl. No.	Name of Items	Unit	Qty
Note : One set consists of quantity required for complete replacement for one pump			
6) Agitators			
Sl. No.	Name of Items	Unit	QTY
1)	Agitator Assembly with Gear Box – Lime Slaking Tank	Set	1
2)	Agitator Assembly with Gear Box – Lime Preparation Tank – PT System	Set	1
3)	Agitator Assembly with Gear Box – Alum Preparation Tank	Set	1
4)	Agitator Assembly with Gear Box – Coagulant aid Tank – CSSP System	Set	1
5)	Agitator Assembly with Gear Box – Flash Mixer	Set	1
6)	Agitator Assembly with Gear Box – Flocculation Tank	Set	1
7) Valves			
Sl. No.	**Name of Items**	**Unit**	**QTY**
1)	Manual Plug Valve	Set	5% or min 1 no of each type & size
2)	Motor operated Plug Valve (without motor actuator)	Set	-do-
3)	Check Valves /Non-return Valve	Set	-do-
4)	Manual Ball Valve	Set	-do-
5)	Motor operated Ball Valve (without motor actuator)	Set	-do-
6)	Manual Globe Valve	Set	-do-
7)	Manual Diaphragm Valve	Set	-do-
8)	Motor operated Diaphragm Valve (without motor actuator)	Set	-do-

Sl. No.	Name of Items	Unit	Qty
9)	Diaphragm for the above Diaphragm Valves	Set	-do-
10)	Manual Butterfly Valve	Set	-do-
11)	Motor operated Butterfly Valve (without motor actuator)	Set	-do-
12)	Manual Gate Valve	Set	-do-
13)	Motor operated Gate Valve (without motor actuator)	Set	-do-

Note : One set consists of quantity required for complete replacement for one valve of each type/ size/Rating.

8) Gravity Filters for PT-Potable

Sl. No.	Name of Items	Unit	QTY
1	Sand and gravel	LOT	One full charge for one filter + 10%
2	Filter flow rate indicator	No	1 no of each type /rating
3	Rate of flow controller	No	1 no of each type /rating
4	Back wash filter flow rate indicator	No	1 no of each type /rating
5	Differential head indicator	No	1 no of each type /rating

9) Gravity Filters for PT-DM

Sl. No.	Name of Items	Unit	QTY
1	Sand and gravel	LOT	One full charge for one filter + 10%
2	Filter flow rate indicator	No	1 no of each type /rating
3	Rate of flow controller	No	1 no of each type /rating
4	Back wash filter flow rate indicator	No	1 no of each type /rating
5	Differential head indicator	No	1 no of each type /rating

10) Air Blowers for Pressure Filters , Sludge pit, Gravity filters			
Sl. No.	**Name of Items**	**Unit**	**QTY**
1	Impeller with shaft	Set	1
2	All Bearings (Blower & Motor)	Set	1
3	Oil seals	Set	1
4	Gears	Set	1
5	Filters	Nos	2
Note : One set consists of quantity required for complete replacement for one blower			

11) Electrically Operated Hoists (For each type & capacity)			
Sl. No.	**Name of Items**	**Unit**	**QTY**
1	Bearings	Set	1
2	Rope guide	Set	1
3	Brake lining	Set	1
4	Wire rope full length	Set	1
Note : One set consists of quantity required for complete replacement for one hoist of each type & capacity			

12) Vertical (wet pit) Pumps- Waste Service water transfer pumps, Coal decanted water, Potable water pumps			
Sl. No.	**Name of Items**	**Unit**	**QTY**
1)	Impeller with nuts & washers	Set	1 set of each type
2)	Bearings for Line, Head and Impeller shafts	Set	-do-
3)	Thrust Bearings of pump & drive	Set	-do-
4)	Wearing rings – Impeller (if applicable)	Set	-do-
5)	Wearing rings – Casing (if applicable)	Set	-do-

6)	Gland, packing & gland assembly	Set	-do-
7)	Impeller Shaft, line shaft and head shaft	Set	-do-
8)	Shaft Sleeves	Set	-do-
9)	Stuffing box	Set	-do-
10)	Pump & Drive Coupling, bushes, pins with all fasteners & coupling guards (as applicable)	Set	-do-
11)	All Gaskets	Set	-do-
12)	Motor Bearings	Set	-do-
13)	Line Shaft Couplings (if applicable)	Set	-do-

Note : One set consists of quantity required for complete replacement for one pump

13) <u>Horizontal Centrifugal Pumps –ACW Makeup Pumps, service water, Air pre heater wash, Chlorine Water Booster Pumps – ACW System, PT System, Final Effluent Disposal Pumps, (If applicable)</u>

Name of Items	Unit	QTY
Impeller for each type	Set	1
Wearing rings – Impeller for each type (if applicable)	Set	1
Wearing rings – Casing for each type (if applicable)	Set	1
Shaft for each type	Set	1
Shaft Sleeves for each type	Set	1
Stuffing box for each type	Set	1
Coupling between Pump & motor, bushes, pins with all fasteners & coupling Guards	Set	1
Pump bearings for each type	Set	1
Gland , Packing & Gland Assembly for each type	Set	1

Note : One set consists of quantity required for complete replacement for one pump

14) Ventilation System

S.N.	Name of Items	Unit	Qty
1	Pre filters & Fine filters	Set	1 Set of each type/size/model

CONTROL & INSTRUMENTATION-PT PLANT

Sl. No.	ITEM	QUANTITY
1.00.00	**MEASURING INSTRUMENTS**	
1)	Electronic Transmitters	
(i)	Transmitters of all types and model. (for the measurement of Pressure, differential pressure, flow, level, etc.) including local indication (if applicable)	10 % or 1 no. of each type and model whichever is more
2)	Temperature elements	
(i)	Temperature Transmitter	10 % or 1 no. of each type and model whichever is more
(ii)	RTD's*	1 no. of each type
(iii)	Thermo well	1 no. of each type
	* (With head assembly, terminal block and nipple)	** (to be divided into various insertion lengths in proportion to main population)
3)	Local Indicators (Non-Electrical type) -As applicable for the package as per the following items	
(i)	Temperature gauges	1 no. of each range and type
(ii)	Pressure gauges	1 no. of each range and type
(iii)	Differential Pressure Gauges,	1 no. of each range and type
(iv)	Level gauges	1 no. of each range and type

Sl. No.	ITEM	QUANTITY
(v)	Flow gauges excluding Rota meters	1 no. of each range and type
(vi)	All types of Rota meters	1 no. of each range and type
4)	Process Actuated Switch Devices -As applicable for this package, as per the following items	
(i)	Temperature switches	1 no. of each range and type
(ii)	Pressure switches	1 no. of each range and type
(iii)	Differential Pressure switches	1 no. of each range and type
(iv)	level switches	1 no. of each range and type
(v)	Flow switches	1 no. of each range and type
5)	Solenoid Valves	10 % or 1 no. of each type and model whichever is more
6)	Limit Switches (for Pneumatic Valves and Manual valves)	2 no. of each type
7)	ANALYSERS	
1)	PH Analyzer	
	(a) Flow Through type cell and Electrode	1 no of each type
	(b) Electronic Transmitter unity without sensor	1 no of each type
	(c) Pre-fabricated cable with connector	1 set
2)	Conductivity Analyzer	
	(a) Flow Through type cell and Electrode	1 no of each type
	(b) Electronic Transmitter unity without sensor	1 no of each type
	(c) Pre-fabricated cable with connector	1 set
3)	Turbidity Analyzer	
	(a) Flow Through type cell and Electrode	1 no of each type
	(b) Electronic Transmitter unity without sensor	1 no of each type
	(c) Pre-fabricated cable with connector	1 set

Sl. No.	ITEM	QUANTITY
4)	Residual Chlorine Analyzer	
	(a) Sensor	1 no of each type
	(b) Transmitter	1 no of each type
	(c) Pre-fabricated cable with connector	1 set
	(d) All Chemical Reagents for 12 month operation (Supply to be staggered as per the shelf life)	1 set
2.00.00	**PROCESS CONNECTION PIPING (FOR IMPULSE PIPING/TUBING, SAMPLING PIPING/TUBING AND AIR SUPPLY PIPING AS APPLICABLE)**	
1)	2 way, 3way, 5way valve manifolds	1 no. of each type, class, size and model

	MANDATORY SPARES FOR CLARIFIER	
Part C		
S.no.	Item Description	Quantity
I	**CLARIFIERS : PT-CW System**	1 no.
1	Turbine drive motor	
II	**CLARIFIER: PT-DM System**	1 no.
1	Turbine drive motor	1 no.
2	Lime Slurry Transfer Pump motor	1 no.
3	Lime Dosing Pumps motor– PT System	1 no.
4	Alum Dosing Pump motor : PT – CW System	1 no.
5	Alum Dosing Pump motor : PT – DM System	1 no.
6	Alum Dosing Pump motor – LET (for tube settlers) System	1 no.
7	Chlorine Water Booster Pump motor – CW System	1 no.
8	Chlorine Water Booster Pump motor – PT System	1 no.
9	Absorbant circulation Pump motor –Chlorine Leak Absorption system	1 no.
10	Vertical Sump Pumps – Filter Back wash water pump motor	1 no.
11	Vertical Sump Pumps – Sludge recirulation pump motor	1 no.
12	Agitator Assembly with Motor & Gear Box – Lime Slaking Tank	1 no.
13	Agitator Assembly with Motor & Gear Box – Lime Preparation Tank – PT System	1 no.
14	Agitator Assembly with Motor & Gear Box – Alum Preparation Tank	1 no.
15	Agitator Assembly with Motor & Gear Box – Coagulant aid Tank – CSSP System	1 no.
16	Air Blowers motor for Gravity Filters	1 no.
17	Vertical (wet pit) Pumps- Potable water pump motor	1 no.
18	Vertical (wet pit) Pumps- Waste Service water transfer pump motor	1 no.
19	Vertical (wet pit) Pumps- Coal Decanted water pump motor	1 no.
20	Treated Service Water Pump motor	1 no.
21	Service Water Pump motor	1 no.
22	Air Pre-heater Wash Water Pump motor	1 no.
23	Final Effluent Disposal Pump motor	1 no.
24	HVAC Pump motor	1 no.
VENTILATION SYSTEM		
Electric motor		1

Notes:

1) Identification: Each spare shall be clearly marked and labelled on the outside of the packing with its description. When more than one spare part is packed in single case, a general description of the contents shall be shown on the outside of such case and a detailed list enclosed. All cases, containers and other packages must be suitably marked and numbered for the purpose of identification.

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COMPUTER FILE NAME : C:\ZZZ.dwg

FROM RAW WATER PUMP HEADER

BHEL ◁ ▷ BIDDER

TERMINAL POINT : 20M FROM AERATOR ℄

LIME SLAKING TANK (2 NOS.)

AGITATOR (TYP.) | DISSOLVING BASKET (TYP.)

LIME SLURRY TANSFER PUMP (2X100%)

LIME SOLUTION PREPARTION TANK (3 NOS.)

LIME SOLUTION DOSING PUMPS (2X100%)

ALUM SOLUTION PREPARATION TANK (4 NOS.)

COAGULANT-AID PREPARATION TANK (2 NOS.)

COAGULANT AID DOSING PUMPS (2X100%)

ALUM DOSING PUMPS (PT O/L) 4 NOS.

STORAGE TANK (PAC) CAP-15 cum.

Fume Absorber (TYP.)

PAC PREPARATION /DOSING TANK (2 NOS.)

PAC DOSING PUMPS (2X100%)

PAC UNLOADING / TRANSFER PUMPS (2X100%)

2 NOS. 80MM DIA FLEXIBLE HOSES OF 20 M LENGTH

COAGULANT-AID PREPARATION TANK (2 NOS.)

COAGULANT AID DOSING PUMPS (2X100%)

SUCTION FILTER

AIR BLOWER (2X100%)

FROM PT-DM GRAVITY FILTERS

FROM PT-POTABLE GRAVITY FILTERS

INLET CHAMBER

FILTER BACKWASH PIT-I

FILTER BACKWASH PIT-II

NOZZLE

FILTER BACKWASH TRANSFER PUMPS (2X100%)

TO SITTLING CHAMBER

TO AGITATION OF PITS & PUMP

OTHER DRAIN FROM STILLING CHAMBER, INLET CHAMBER ETC.

SLUDGE FROM ALL THE CLARIFIERS

OVERFLOW & DRAIN FROM CHEMICAL TANKS

SLUDGE FROM TUBE SETTLER / LAMELLA CLARIFIER (BHEL's SCOPE)

INLET CHAMBER FOR SLUDGE PIT

SLUDGE PIT COMP-1

SLUDGE PIT COMP-2

SLUDGE TRANSFER PUMPS (3X50%)

FOR SLUDGE RECIRCULATION

FROM RAW WATER PUMP HEADER

FILTERED WATER OVER HEAD TANK

FILTERED WATER FLUSHING LINE

LIME RECIRCULATION RING HEADER

TO LUBRICATION & FLUSHING PUMP

BLANKED CONNECTION

TO CLO2 GEN PLANT

TO SLUDGE PIT

TO FILTER BACK WASH PT-DM

TO FILTER BACK WASH PT-POTABLE

PUMP DISCHARGE FROM POTABLE WATER

FROM FILTER BACKWASH PUMP DISCHARGE

FROM CLO2 DOSING GENERATOR (BHEL'S SCOPE)

BAFFLE WALL (TYP.)

AERATOR

STILLING CHAMBER

TO FILTER BACKWASH SUMP

CONTROL VALVE SYSTEM

PARSHALL FLUME(TYP.)

INLET CHAMBER

TELESCOPIC DEVICE

TO SLUDGE SUMP

BYPASS CHANNEL

COAGULANT AID

ALUM

PAC

VFD

FOR SAMPLING

OC-LS

WS-DDCMS

PT - CW CLARIFIER (2 NOS.)

TO FILTER BACKWASH SUMP

PAC DOSING

ALUM DOSING

PT - DM CLARIFIER (2 NOS.)

SUPERNATANT TRANSFER PUMPS (1W+1S)

(INST. BY BIDDER) INTERLOCK TO BE PROVIDED WITH INLET CONTROL VALVE (TYP.)

CLARIFIED WATER DISTRIBUTION CHAMBER (CIVIL-BHEL'S SCOPE)

FILTER BACKWASH LINE

BACK UP LINE

GRAVITY FILTER

TO FILTER BACKWASH PIT

SUCTION FILTER (TYP.)

AIR BLOWER (3X50%)

FROM CLO2 DOSING GENERATOR (BHEL'S SCOPE)

POTABLE WATER FOR PLANT DIST (TP : 5M FROM PUMP DISCHARGE)

POTABLE WATER FOR COLONY DIST. (TP : 32.5m(T.W.E.)/615656.60 N)

FILTERED WATER RESERVOIR

POTABLE WATER PUMPS

BIDDER

BHEL

DM WATER FOR DM PLANT (REF. P&ID FOR DM PLANT) (PE-DG-405-163-A001)

FILTERED WATER RESERVOIR DM PLANT FEED PUMPS (BHEL's SCOPE)

THICKENER (MOC-STEEL)

TO SLUDGE PIT

SLUDGE THICKENER

FLASHING LINE

SLUDGE TRANSFER PUMPS (1W+1S)

SUCTION FILTER

AIR BLOWER (2X100%)

THICKEND WASTE SUMP

SLUDGE DISPOSAL PUMPS (2W+1S)

SOLID CAKE

CENTERIFUGE 2X50%

CLEAR WATER TO THICKENER INLET

DUMPER TROLLEY EACH CAPACITY=5M3

LEGEND

	FLOAT VALVE
	AIR BLOWER
	DIAPHRAGM SEAL
OC-LS	OPEN CLOSE LEVEL SWITCH
	ISOLATION GATE
ZT	POSITION TRANSMITTER
	PARSHALL FLUME
	PLUG VALVE
	GATE VALVE
	GLOBE VALVE
	BALL VALVE
	BUTTERFLY VALVE
	PRESSURE RELIEF VALVE
	NON RETURN VALVE
	BUTTERFLY VALVE ELECTRICALLY OPERATED
	DIAPHRAGM VALVE NORMALLY OPEN / NORMALLY CLOSED
	PNEUMATICALLY OPERATED
	'Y' TYPE STRAINER
	FUNNEL
	ORIFICE PLATE
LS	LEVEL SWITCH
PS	PRESSURE SWITCH
LI	LEVEL GAUGE
LGF	LEVEL GAUGE (FLOAT TYPE)
LGR	LEVEL GAUGE (REFLEX TYPE)
PI	PRESSURE INDICATOR
FI	FLOW INDICATOR
FT	FLOW TRANSMITTER
	MOTOR OPERATED
LT	LEVEL TRANSMITER
DDCMS	DISTRIBUTED DIGITAL CONTROL MONITORING AND INFORMATION SYSTEM (OWNER'S)
	PUMP
	NIDDLE VALVE
	GATE VALVE (MOTORIZED-INCHING TYPE)
	BUTTERFLY VALVE (MOTORIZED-INCHING TYPE)

NOTES

1. PIPE LINE SIZE INDICATED ARE IN mm (NB).
   1.1. CARBON STEEL PIPING UP TO AND INCLUDING 150NB SHALL BE ERW, IS: 1239 (HEAVY GRADE)
   1.2. CARBON STEEL PIPING 200NB AND ABOVE SHALL BE IS: 2062. ROLLED & WELDED CONFIRMING TO IS 3589.
2. THE P&I DIAGRAM IS TENTATIVE AND ONLY MINIMUM REQUIREMENT OF VALVES, INSTRUMENTATION ETC. HAS BEEN SHOWN. BIDDER SHOULD FURNISH COMPLETE SCHEME IN ALL RESPECTS INCLUDING ALL INSTRUMENTS, VALVES ETC. FOR SMOOTH, SAFE, EFFICIENT, TROUBLE FREE OPERATION OF PLANT FOR BHEL / CUSTOMER APPROVAL DURING DETAILED ENGINEERING.
3. LIME SOLUTION HEADER SHALL COVER ALL THE CLARIFIERS BEFORE RETURNING TO THE PREPARATION/DOSING TANK .TAPPING FROM THIS HEADER SHALL BE TAKEN NEAR THE INDIVIDUAL CLARIFIER.
4. ALL VARIABLE FREQUENCY DRIVES (VFD) SHALL BE CONTROLLED FROM DDCMIS.
5. SUITABLE PERMANENT FLUSHING CONNECTION SHALL BE PROVIDED FOR ALL PIPIELINES CARRYING SLUDGE AND CHEMICAL LINES. IN CASE, ADEQUATE PRESSURE IS NOT AVAILALBLE, SEPARATE BOOSTER PUMPS (2X100%) SHALL BE PROVIDED FOR THE SAME.
6. ALL RECIRCULATION LINES SHALL BE PROVIDED WITH SUITABLE ORIFICE PLATE & SHALL BE DESIGNED BASED ON 50% OF EACH PUMP CAPACITY.
7. WIDTH OF GATES SHALL BE SAME AS THAT OF CHANNEL. CHANNEL WIDTH SHALL BE INCREASED LOCALLY, IF REQUIRED.
8. ALL THE PIPE AND VALVE SIZES AND ANY OTHER SIZES INDICATED IN THE DRAWING ARE MINIMUM REQUIREMENT. PIPE & VALVES SIZES SHELL BE INCREASED WHERE EVER REQUIRED TO MEET THE SYSTEM REQUIREMENT.
9. OVER FLOW & DRAINS FROM VARIOUS CHEMICAL TANKS & FLOOR WASH DRAINS OF CHEMICAL HOUSE BUILDING (EXCEPT OVER FLOW O/H FILTERED WATER STORAGE TANK) SHALL BE LED TO THE PT PLANT CLARIFIER SLUDGE SUMP.
10. OVER FLOW & DRAINS FROM STRUCTURES AND PIPING HANDLING CLEAR RAW WATER, CLARIFIED WATER AND FILTERED WATER IN PTP SUCH AS AERATOR, STILLING CHAMBER, INLET CHAMBER ETC. SHALL BE LED TO BE TO FILTER BACK WASH SUMP.
11. OVER FLOW & DRAINS FROM FILTERED WATER RESERVOIR , FILTER WATER SUMP ETC. SHALL BE LED TO THE BACK WATER SUMP.
12. THE INSTRUMENTS, VALVES, PIPING, FITTINGS, ETC SHOWN IN P & ID ARE MINIMUM. THE ADDITIONAL VALVES, INSTRUMENTS, PIPING, FITTINGS ETC. SHALL ALSO BE INCLUDED AS INDICATED ELSEWHERE IN THE SPECIFICATION & BASED ON SYSTEM REQUIREMENT. THE P&ID TO BE READ IN CONJUNCTION WITH THE TECHNICAL DETAILS SPECIFIED IN OTHER PART OF TECHNICAL SPECIFICATION.

REV	DATE	ALTD	CHD	APPD	REV	DATE	ALTD	CHD	APPD

JOB No. 434
STATUS CONTRACT
DISTRIBUTION
TO
No.OFF

OWNER: NTPC Limited (A GOVERNMENT OF INDIA ENTERPRISE)

PROJECT: 3X800 MW PATRATU STPP EXT.PH-I

ENGG / SUB CONTRACTOR: BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA

DEPT CODE		NAME	SIGN	DATE
A	DRN	VK		
	DESN	VK		
	CHD	SB		
	APPD	SB		

TITLE: P&I DIAGRAM FOR PRE-TREATMENT PLANT

MPL	C	MSE	I	MAX	E	DEPT.	SCALE
						SIGN	
						DATE	

DRAWING No. PE-DG-434-158-A001

SHEET 01 OF 01 REV 00

SIZE-A1

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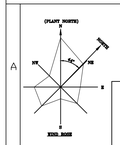
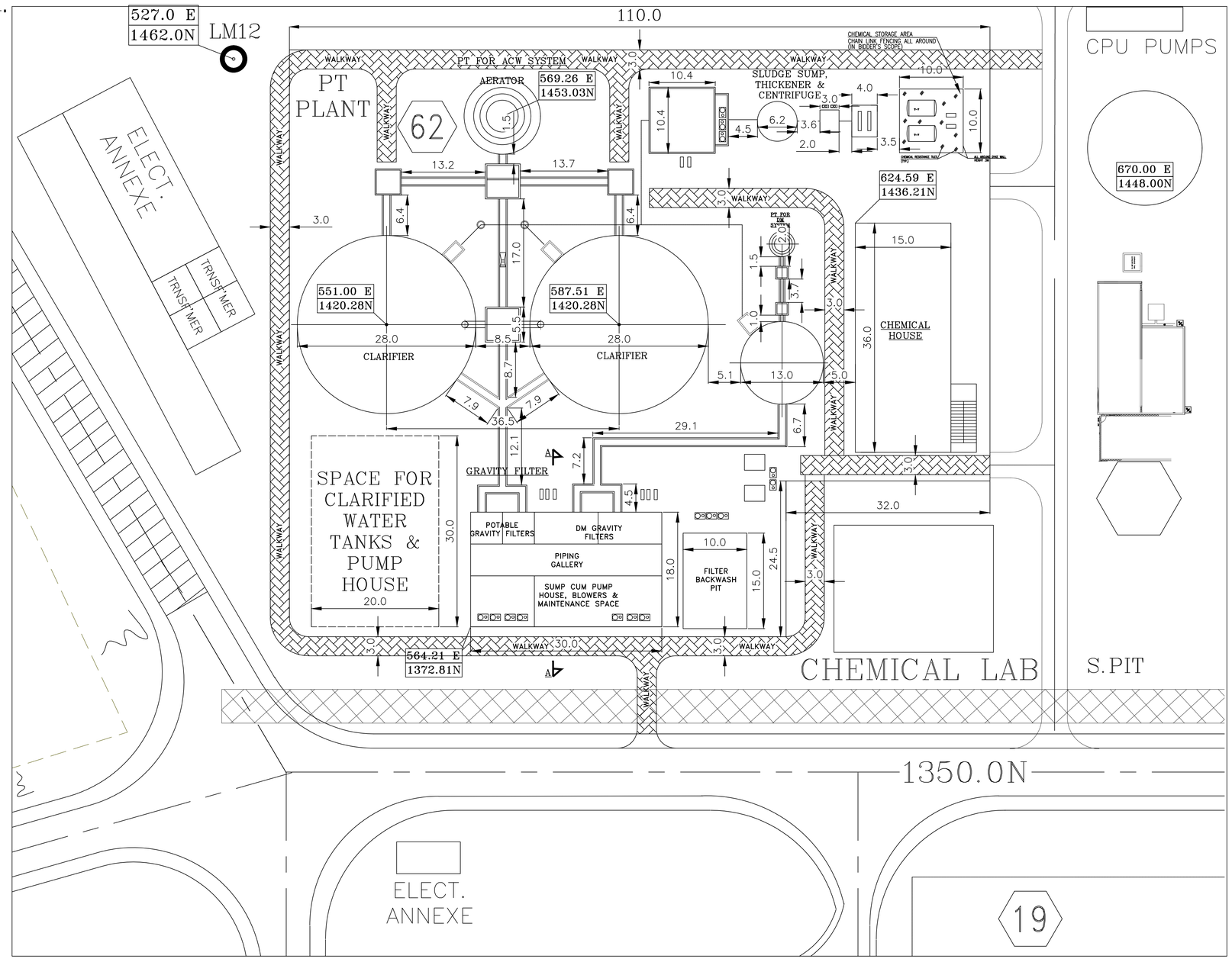
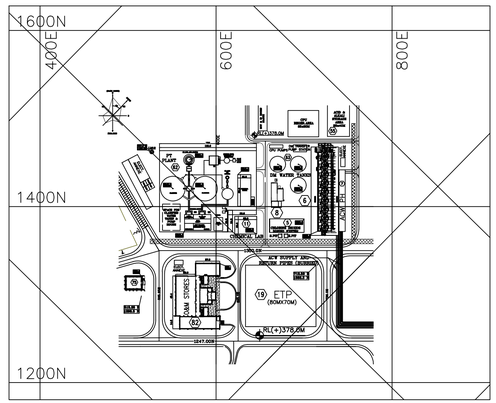
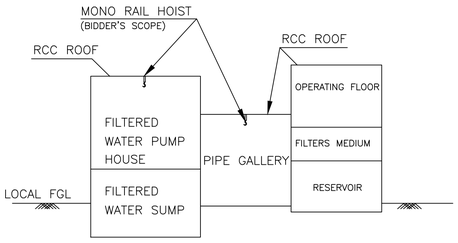






KEY PLAN



SECTION A–A

NOTES:

1. ALL DIMENSIONS AND ELEVATIONS ARE IN METRES.
2. ALL CHEMICAL DRAIN CHANNELS WILL BE PROVIDED WITH ACID/ALKALI RESISTANT TILING.
3. CHEMICAL DYKE AREA FLOOR, WALLS & SADDLE SUPPORT TO BE PROVIDED WITH CHEMICAL RESISTANT TILING.
4. THE DIMENSIONS SHOWN HERE ARE INDICATIVE AND FINAL DIMENSIONS SHALL BE AS PER THE CONTRACT REQUIREMENT.

JOB No.	434			
STATUS	CONTRACT			
DISTRIBUTION				
TO				
NoOFF				
REV	DATE	ALTD	CHD	APPD

NTPC DRAWING NO. ----------

OWNER: NTPC — **NTPC Limited** (A GOVERNMENT OF INDIA ENTERPRISE)

PROJECT: 3X800 MW PATRATU STPP EXT.PH-I

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA

DEPT CODE		NAME	SIGN	DATE
A	DRN	VK		
	DESN	VK		
	CHD	SB		
	APPD	SB		

TITLE: LAYOUT FOR PRETREATMENT PLANT

MPL	C	MSE	I	MAX	E	DEPT.	SCALE
						SIGN	
						DATE	

DRAWING No. PE-DG-405-158A-A001A

OF | REV 00

SIZE-A1

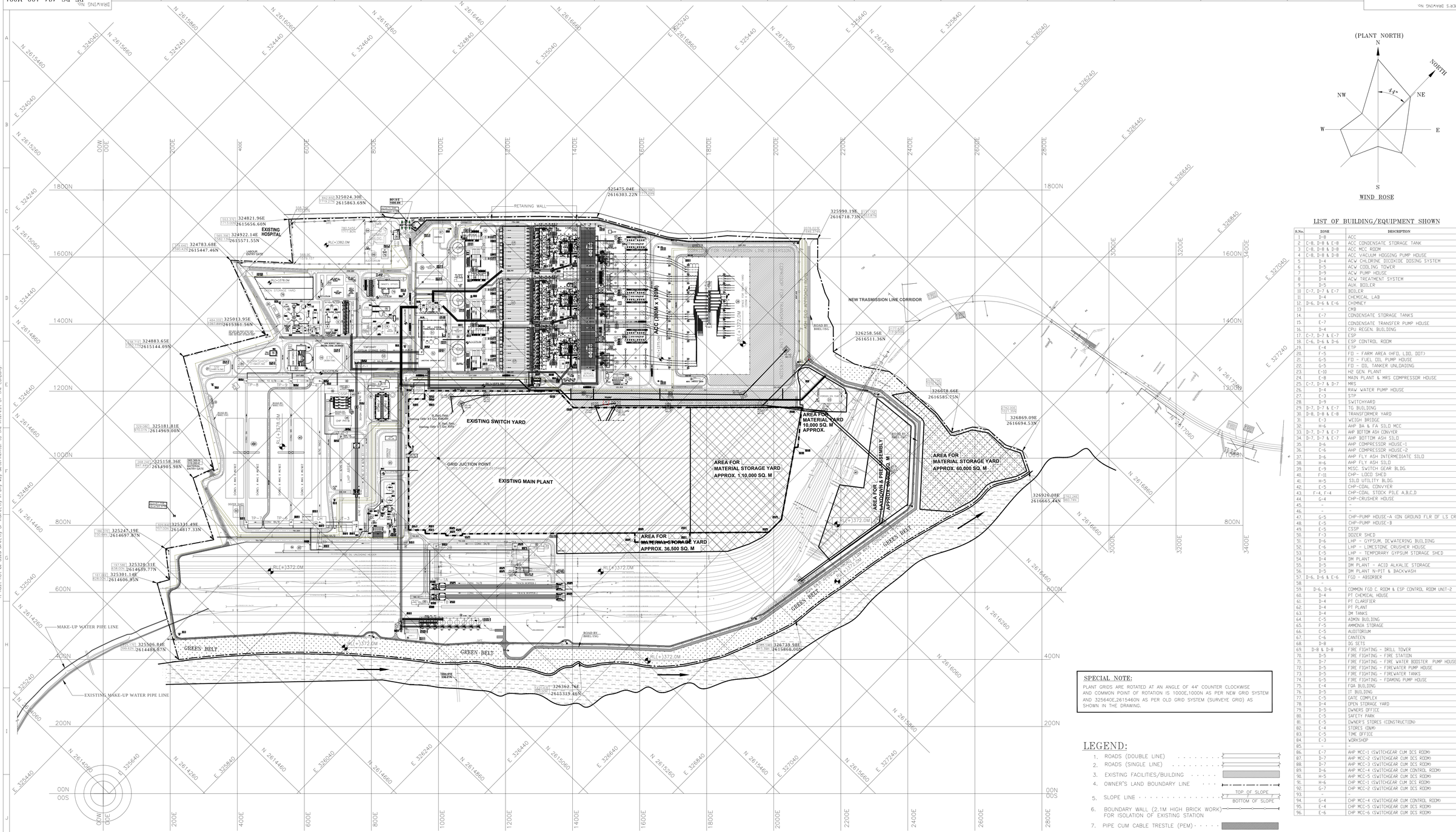
COMPUTER FILE NAME : TAL5

DRAWING No. PE-DG-434-100-M001

CUSTOMER'S DRAWING No.

FIRST ANGLE PROJECTION

ALL DIMENSIONS ARE IN MM



LIST OF BUILDING/EQUIPMENT SHOWN

S.No.	ZONE	DESCRIPTION
1	D-8	ACC
2	C-8, D-8 & E-8	ACC CONDENSATE STORAGE TANK
3	C-8, D-8 & E-8	ACC MCC ROOM
4	C-8, D-8 & D-8	ACC VACUUM HOGGING PUMP HOUSE
5	D-4	ACW CHLORINE DICOXIDE DOSING SYSTEM
6	D-5	ACW COOLING TOWER
7	D-9	ACW PUMP HOUSE
8	D-4	ACW TREATMENT SYSTEM
9	D-5	AUX. BOILER
10	C-7, D-7 & E-7	BOILER
11	D-4	CHEMICAL LAB
12.	D-6, D-6 & E-6	CHIMNEY
13	–	CMB
14.	E-7	CONDENSATE STORAGE TANKS
15.	E-7	CONDENSATE TRANSFER PUMP HOUSE
16.	D-4	CPU REGEN. BUILDING
17.	C-7, D-7 & E-7	ESP
18.	C-6, D-6 & D-6	ESP CONTROL ROOM
19.	E-4	ETP
20.	F-5	FO – FARM AREA OHFO, LDO, DOT)
21.	G-5	FO – FUEL OIL PUMP HOUSE
22.	G-5	FO – OIL TANKER UNLOADING
23.	E-10	H2 GEN. PLANT
24.	E-8	MAIN PLANT & MRS COMPRESSOR HOUSE
25.	C-7, D-7 & D-7	MRS
26.	D-4	RAW WATER PUMP HOUSE
27.	E-3	STP
28.	D-9	SWITCHYARD
29.	D-7, D-7 & E-7	TG BUILDING
30.	D-8, D-8 & E-8	TRANSFORMER YARD
31.	E-3	WEIGH BRIDGE
32.	H-6	AHP BA & FA SILO MCC
33.	D-7, D-7 & E-7	AHP BOTTOM ASH CONVYER
34.	D-7, D-7 & E-7	AHP BOTTOM ASH SILO
35.	D-6	AHP COMPRESSOR HOUSE-1
36.	C-6	AHP COMPRESSOR HOUSE-2
37.	D-6	AHP FLY ASH INTERMEDIATE SILO
38.	H-6	AHP FLY ASH SILO
39.	E-9	MISC. SWITCH GEAR BLDG.
40.	F-11	CHP- LDCD SHED
41.	H-5	SILO UTILITY BLDG.
42.	E-5	CHP-COAL CONVEYER
43.	F-4, F-4	CHP-COAL STOCK PILE A,B,C,D
44.	G-4	CHP-CRUSHER HOUSE
45.	–	–
46.	–	–
47.	G-5	CHP-PUMP HOUSE-A (ON GROUND FLR OF LS CRH)
48.	E-5	CHP-PUMP HOUSE-B
49.	E-5	CSSP
50.	F-3	DOZER SHED
51.	D-6	LHP – GYPSUM, DEWATERING BUILDING
52.	E-6	LHP – LIMESTONE CRUSHER HOUSE
53.	E-5	LHP – TEMPORARY GYPSUM STORAGE SHED
54.	D-4	DM PLANT
55.	D-5	DM PLANT – ACID ALKALIE STORAGE
56.	D-5	DM PLANT N-PIT & BACKWASH
57.	D-6, D-6 & E-6	FGD – ABSORBER
58.	–	–
59.	D-6, D-6	COMMON FGD C. ROOM & ESP CONTROL ROOM UNIT-2
60.	D-4	PT CHEMICAL HOUSE
61.	D-4	PT CLARIFIER
62.	D-4	PT PLANT
63.	D-4	DM TANKS
64.	C-5	ADMIN BUILDING
65.	F-5	AMMONIA STORAGE
66.	C-5	AUDITORIUM
67.	C-6	CANTEEN
68.	D-8	DG SETS
69.	D-8 & D-8	FIRE FIGHTING – DRILL TOWER
70.	D-5	FIRE FIGHTING – FIRE STATION
71.	D-7	FIRE FIGHTING – FIRE WATER BOOSTER PUMP HOUSE
72.	D-5	FIRE FIGHTING – FIREWATER PUMP HOUSE
73.	D-5	FIRE FIGHTING – FIREWATER TANKS
74.	G-5	FIRE FIGHTING – FOAMING PUMP HOUSE
75.	E-4	FOA BUILDING
76.	D-5	IT BUILDING
77.	C-5	GATE COMPLEX
78.	D-4	OPEN STORAGE YARD
79.	D-5	OWNERS OFFICE
80.	C-5	SAFETY PARK
81.	E-5	OWNER'S STORES (CONSTRUCTION)
82.	E-4	STORES (O&M)
83.	C-5	TIME OFFICE
84.	E-3	WORKSHOP
85.	–	–
86.	E-7	AHP MCC-1 (SWITCHGEAR CUM DCS ROOM)
87.	D-7	AHP MCC-2 (SWITCHGEAR CUM DCS ROOM)
88.	D-7	AHP MCC-3 (SWITCHGEAR CUM DCS ROOM)
89.	D-6	AHP MCC-4 (SWITCHGEAR CUM CONTROL ROOM)
90.	H-5	AHP MCC-5 (SWITCHGEAR CUM DCS ROOM)
91.	H-6	CHP MCC-1 (SWITCHGEAR CUM DCS ROOM)
92.	G-7	CHP MCC-2 (SWITCHGEAR CUM DCS ROOM)
93.	–	–
94.	G-4	CHP MCC-4 (SWITCHGEAR CUM CONTROL ROOM)
95.	E-4	CHP MCC-5 (SWITCHGEAR CUM DCS ROOM)
96.	E-6	CHP MCC-6 (SWITCHGEAR CUM DCS ROOM)

SPECIAL NOTE:

PLANT GRIDS ARE ROTATED AT AN ANGLE OF 44° COUNTER CLOCKWISE AND COMMON POINT OF ROTATION IS 1000E,1000N AS PER NEW GRID SYSTEM AND 325640E,2615460N AS PER OLD GRID SYSTEM (SURVEYE GRID) AS SHOWN IN THE DRAWING.

LEGEND:

1. ROADS (DOUBLE LINE)
2. ROADS (SINGLE LINE)
3. EXISTING FACILITIES/BUILDING
4. OWNER'S LAND BOUNDARY LINE
5. SLOPE LINE (TOP OF SLOPE / BOTTOM OF SLOPE)
6. BOUNDARY WALL (2.1M HIGH BRICK WORK) FOR ISOLATION OF EXISTING STATION
7. PIPE CUM CABLE TRESTLE (PEM)
8. CABLE TRESTLE (PEM)
9. CONSTRUCTION LIGHTNING MAST

REFERENCE DRGS:

SL No.	TITLE	DRG. NUMBER	SCOPE
1	REFERENCE PLOT PLAN	9585-999-P0C-F-001	NTPC

NOTES:–

1. ALL DIMENSIONS ARE IN MM & ELEVATIONS IN METERS UNLESS STATED OTHERWISE.
2. FINISH FLOOR LEVEL = RL (+)375.50 M,CORRESPONDS TO PLANT EL 0.0M (GROUND FLOOR OF STG BUILDING) FINISHED GROUND LEVEL OF BOP AREAS AS MARKED.
3. LOCATION/SIZE OF BOP FACILITIES IS TENTATIVE ONLY

40 0 40 80 120 160M
SCALE

REV.	DATE	ALTD	CHD	APPD
2	27.09.2018	RC	BKA	JJ
1	DRAWING REVISED AS PER LATEST GAs OF DIFFERENT FACILITIES & NTPC COMMENTS ON REV. 1			

REV.	DATE	ALTD	CHD	APPD
1	16.07.2018	RC	BKA	JJ
1	DRAWING REVISED AS PER LATEST GAs OF DIFFERENT FACILITIES & NTPC COMMENTS ON REV. 0			

NTPC DRG NO.: 9585-001-999-P0C-F-001

CUSTOMER: NTPC LIMITED

3x800MW PATRATU SUPER THERMAL POWER PROJECT

JOB NO. 434
STATUS CONTRACT
DISTRIBUTION

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA

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	DEPT	NAME	SIGN	DATE
DRN	M	WS		26.03.2018
DESN		DEEPAK/RC		26.03.2018
CHD		BKA		26.03.2018
APPD		JJ		26.03.2018

TITLE: PLOT PLAN

DEPT. M | SCALE 1:425 | SIGN

DRAWING NO. PE-DG-434-100-M001

SHEET 1 OF 1 | REV. 2

SIZE-A0

COMPUTER FILE NAME: 434_100_M001

DATASHEET-A

(PRE TREATMENT PLANT)

DATA SHEET – A

1.	**INLET VALVES**	
1.1	Inlet valves for PT-CW clarifiers & PT-DM clarifier.(Each)	One (1) number motorized butterfly flow control valve, located at inlet to each aerator, with manual upstream and downstream isolation valves along with by-pass motorized butterfly flow valve. Control valve shall have “auto manual” selection option, position indicator with “open-close” push buttons. Inching operation of valve shall be possible from DDCMIS.
1.2	Inlet control valve size	Suitable to cater to total flow
1.3	Code	AWWA – C 504/EN 593/Equivalent Std. of required class/rating.
1.4	Control	Under “ Auto” mode of flow control valve, valve shall automatically maintain the level of water in the clarified water reservoir, i.e valve shall automatically close when reservoir level becomes high.
2.	**AERATOR**	
2.1	Type	Cascade Type
2.2	Nos.	Two (2) [One (1) for PT-ACW Clarifier and One (1) for PT-DM Clarifier]
2.3	Capacity(Design flow) Each.(Min.)	PT-ACW -2900 CuM/Hr + 3% for sludge (each). PT-DM - 360 CuM/Hr + 3% for sludge (each).
2.4	Material of construction	RCC
2.5	Retention time	1 min
2.6	Surface flow rate	0.03 m^3/ hr/ m^2
3.	**STILLING CHAMBER**	
3.1	No.	Two (2) Numbers [One for PT-ACW and one for PT-DM]
3.2	Purpose	To dampen out any turbulence of the incoming water.
3.3	Retention time	1 min minimum.
3.4	Velocity of water rise	0.05 m/sec
3.5	Capacity(Design flow)	PT-ACW -2900 CuM/Hr + 3% for sludge (each). PT-DM - 360 CuM/Hr + 3% for sludge (each).
3.6	Material of construction	RCC
3.7	Drain arrangement	Suitable draining arrangement shall be provided for the stilling chamber and drain lines shall be connected to sludge sump.
4.	**PARSHALL FLUME**	
4.1	No.	Three (3) numbers [Two (2) for PT-ACW and one (1) number PT-DM].
4.2	Purpose	To measure flow.
4.3	Material of construction	RCC
5.	**INLET CHANNEL**	
5.1	Nos.	Three (3) numbers [Two (2) for PT-ACW and One (1) for PT-DM].
5.2	Capacity (Design flow).each	PT-ACW -1450 CuM/Hr + 3% for sludge (each). PT-DM - 360 CuM/Hr + 3% for sludge (each).
5.3	MOC	RCC
6.	**HRSCC (HIGH RECOVERY SOLID CONTACT CLARIFIER)**	
6.1	Number	Three (3) [Two (2X50 %) numbers for PT-CW Clarifier and one (1X100 %) number PT-DM Clarifier]
6.2	Design Flow (Min) Net output	PT-CW Clarifier -1450 Cum/Hr (each). PT-DM Clarifier -360 Cum/Hr

6.3	Type	High Rate Solids Contact Type Clarifier (HRSC).
6.4	MOC	RCC
6.5	MOC of pipe from inlet channel to clarifier	Carbon Steel pipe encased with concrete for buried portion and externally epoxy painted inside the clarifier.
6.6	Sludge Blow Off	By gravity through telescopic stand-pipe for continuous discharge and through manual operated blow-off valve for intermittent.
6.7	Sludge Blow Off- Pipe Material	CI class A as per IS: 1536)
6.8	Platform with hand railing	Shall be provided (1 meter wide all along Clariflocculator)
6.9	Rake bridge	Shall be provided.
6.10	Flocculation agitator	Two (2) Numbers per clarifier. Vertical slow speed motor reduction gear driven.
7.	**CLARIFIER SCRAPPERS**	
7.1	Number required	One per clarifier.
7.2	Material	Mild steel (MS) with rubber inserts (With bitumastic paint protective coating)
7.3	Traction drive	Slow speed motor driven through reduction gear unit or VFD as per manufacturer's std.
8.	**SUITABLE ACCESSORIES**	
8.1	Access ladder, platform, staircase, hand railings etc.	Shall be provided of structural steel.
8.2	Walkway	Shall be provided with hand railings around launder periphery of width 1000 mm.
8.3	Electrical requirements	For each HRSCC, one (1) Distribution Board to be located on HRSCC bridge for all drives of HRSCC bridge assembly.
9.	**SLUDGE PIT**	
9.1	Number	One (1) with two compartments.(Under Ground)
9.2	Capacity (effective) Each section	Not Less than 100 cum.
9.3	Dimension	Suitable
9.4	Material	RCC with epoxy paint.
9.5	Location	Shall be finalized during Detailed Engineering (DDE).
9.6	Special arrangement	Agitation/ recirculation line shall be provided in pit.
10.	**AIR BLOWER FOR SLUDGE PIT & BACKEASH PIT**	
10.1	Number	Two (1W+1S)
10.2	Type	Centrifugal /Twin Lobe Type
10.3	Duty	Intermittent
10.4	Capacity & Head	As required
10.5	MOC of casing and lobes	CI as per IS 210 FG 260
10.6	MOC of shaft	Carbon steel BS-970 En-8/ANSI-I045
10.7	Accessories Required	Acoustic Enclosures. Suction Filter, Silencer, relief Valve etc
10.8	Location	Outdoor
11.	**THICKENER**	
11.1	Type	Circular (Center Drive Mechanism).
11.2	Number of units	1 no.
11.3	Capacity	30 cum/hr.
11.4	MOC of Thickener	Steel

11.5	Full bridge	Provided. (MOC: MS)
11.6	Scrapper rake	Provided. (MOC: MS)
11.7	Torque switch for alarm and for tipping	Provided.
12.	**THICKENED WASTE SUMP**	
12.1	Number	One (1) with two compartments.(Under Ground)
12.2	Capacity (effective) Each section	Not Less than 35 cum.
12.3	Dimension	Suitable
12.4	Material	RCC with epoxy paint.
12.5	Location	Shall be finalized during Detailed Engineering (DDE).
12.6	Special arrangement	Agitation/ recirculation line shall be provided in pit.
13.	**SUPERNATANT COLLECTION SUMP**	
13.1	Number	One (1) with two compartments.(Under Ground)
13.2	Capacity (effective) Each section	Not Less than 25 cum.
13.3	Dimension	Suitable
13.4	Material	RCC with epoxy paint.
13.5	Location	Shall be finalized during Detailed Engineering (DDE).
13.6	Special arrangement	Agitation/ recirculation line shall be provided in pit.
14.	**CENTRIFUGE**	
14.1	No. Of units	2x50%
14.2	Type	Variable differential speed control type
14.3	Capacity	As Required
14.4	Screening at inlet	Required
14.5	a) Centrate b) Drive	To be discharged at thickener inlet Hydraulic coupling to dampen the initial acceleration.
14.6	Type	Variable differential speed control type
15.	**GRAVITY FILTER**	
15.1	Number	Four (4) [Two (2X100 %) for PW System and Two (2X100 %) for DM System]
15.2	Type	Twin Section
15.3	Design Capacity (each) Net Output	170 Cum/hr for PW System & 100 Cum/hr for PW System
15.4	Maximum Flow (each)	170 Cum/hr + 2% for PW System & 100 Cum/hr + 2% for PW System
15.5	Media type	Sand/Anthracite coal.
15.6	Supporting Material	Graded Gravel
15.7	MOC	RCC
15.8	Back wash interval	24 hrs.
15.9	Free board	50%
15.10	Filter Flow Rate at max. flow rate	Not more than 5 m3/m2/hr
16.	**AIR BLOWER FOR FILTER**	
16.1	Number	Three (2W+1S) each for PW System & DM system
16.2	Type	Centrifugal /Rotary Twin Lobe Type

16.3	Duty	Intermittent
16.4	Capacity & Head	As required
16.5	MOC of casing ,cover ,stator & Impeller/Lobe	CI as per IS 210 FG 260
16.6	MOC of shaft	Carbon steel BS-970 En-8/ANSI-I045
16.7	Accessories Required	Acoustic Enclosures, Suction Filter, Silencer, relief Valve etc
16.8	Location	Outdoor
17.	**FILTER BACKWASH WASTE COLLECTION PIT**	
17.1	Number	One (1) with two Sections.
17.2	Capacity (effective) Each section	Not Less than 150 cum.
17.3	Dimension	Suitable
17.4	Material	RCC with Acid/Alkali Proof Lining.
18.	**FILTERED WATER RESERVOIR**	
18.1	Number	Two (2) numbers. [One (1) for PW System and One (1) for DM System]
18.2	Type	Twin Section
18.3	Capacity each section	To store filtered water output from one complete filter for one (1) hour.
18.4	Material	RCC.
19.	**CHEMICAL HOUSE**	
19.1	Number	One (1).for both Pre Treatment & Effluent Treatment Plant.
19.2	Type	Two storied building of civil construction.
19.3	Building dimensions	DDE
19.4	Ground floor	Storage of chemical required for Alum, Lime and Poly Electrolyte,PAC, dosing for 15 days storage capacity. For both PT & ET Plant
19.5	First floor	Location of all chemical dosing tanks and pumps for entire PT & ET Plant.
20.	**WEIGHING SCALE FOR CHEMICAL**	
20.1	Type	Platform & dial type./electronic type
20.2	Number	Two (2) [One of 0-500 Kg & One Of 0-2000 Kg]
21.	**HOIST**	
21.1	Type	Electric operated
21.2	Number	Two (2).
21.3	Capacity (each)	2 T
21.4	Design Standard	IS:3938 Class 2
22.	**CHEMICAL DOSING**	
22.1	**ALUM SOLUTION PREPARATION & DOSING SYSTEM**	
	a) Tank –	Number-Four (4) numbers Capacity (each)- To store alum solution (of about 10% W/V concentration) for 8 hrs req. of all clarifier operating at its design capacity and a dosing rate of 70 ppm min, Whichever is maximum. Material- RCC with acid/alkali resistant tiles. Dissolving basket (each tank)-SS 316 Motorized Stirrer (MOC (impeller & Shaft)-SS316)- One (1) number per tank

	b) Pump -	Number-(4x100%) (3W+1S),For PT-ACW clarifier, (2x100%) (1W+1S) for PT-DM Clarifier, (2x100%) (1W+1S) for Lamella Clarifier/Tube Settler. Type – Simplex hydraulically operated diaphragm type. Capacity- As per System Requirement.
22.2	**LIME PREPARATION & DOSING SYSTEM**	
	a) Lime Slaking Tank –	Number-Two (2) numbers lime slaking tanks Capacity (each) - To hold lime slurry (of about 10% W/V concentration from Quick lime of purity of 75% CaO) for 12 hours requirement of all the clarifiers operating at design capacity and a design dosage rate of 30 ppm minimum, Whichever is maximum. Material- RCC. with two (2) coats of bitumastic paint over two (2) coats of primer. Dissolving basket (each tank)-SS 316 Motorized Stirrer (MOC (impeller & Shaft)-SS316)- One (1) number per tank
	b) Lime Dosing Tank –	Number-Three (3) numbers lime solution dosing tanks. Capacity (Each)- To hold lime solution (of about 6% W/V concentration) for 8 hours requirement of all the clarifiers operating at its design capacity and a design dosage rate of 30 ppm minimum, Whichever is maximum. Material- RCC. with two (2) coats of bitumastic paint over two (2) coats of primer. Dissolving basket (each tank)-SS 316 Motorized Stirrer (MOC (impeller & Shaft)-SS316)- One (1) number per tank
	b) Pump-	Number-Two (2) numbers (1W+1S) lime slurry transfer pump & Two (2) numbers (1W+1S) lime solution dosing pump. Type – Horizontal Centrifugal non clogging type. Capacity- As per system requirement.
22.3	**COAGULANT AID DOSING SYSTEM. (CLARIFIERS)**	
	a) Tank –	Number- Two (2) numbers. Capacity (each)- To hold coagulant for 12 hours requirement of all the clarifiers operating at design capacity and a design dosage rate of 2 ppm minimum, Whichever is maximum. Material- MSRL Motorized Stirrer (MOC (impeller & Shaft)-SS316)- One (1) number per tank
	b) Pump-	Number-Two (2) numbers (1W+1S). Type – Simplex hydraulically operated diaphragm type. Capacity- As per system requirements.
22.4	**COAGULANT AID DOSING SYSTEM. (THICKENER & CENTRIFUGES)**	
	a) Tank –	Number- Two (2) numbers. Capacity (each)- 12 hour requirement of thickeners and centrifuge. Whichever is more. Material- MSRL Motorized Stirrer (MOC (impeller & Shaft)-SS316)- One (1) number per tank
	b) Pump-	Number-Two (2) numbers (1W+1S). Type – Simplex hydraulically operated diaphragm type. Capacity- As per system requirements.
22.5	**PAC UNLOADING & DOSING SYSTEM. (THICKENER & CENTRIFUGES)**	
	a) Storage Tank –	Number- Two (2) numbers. Capacity (each)- 15 cum. Material- MSRL
	b) Unloading Pumps-	Number-Two (2) numbers (1W+1S) Type – Horizontal Centrifugal non clogging type. Capacity- 10 cum/hr, Head.-10 mlc.

	a) Tank –	Number- Two (2) numbers. Capacity (each)- To hold coagulant for 12 hours requirement of all the clarifiers operating at design capacity and a design dosage rate of 2 ppm minimum, Whichever is maximum. Material- MSRL Motorized Stirrer (MOC (impeller & Shaft)-SS316)- One (1) number per tank
	b) Dosing Pump -	Number-(2x100 Type – Simplex hydraulically operated diaphragm type. Capacity- As per System Requirement. MOC-AISI 316 Liquid end (pump head valve, valve housing, etc) ,valve spring Diaphragm-PTFE Packing-PTFE Shaft-Hardened steel (EN8-BS-970)/AISI-316

23. MOC and type of the pumps shall be as per the following details.

	Pump Description	Quantity	Pump Type	Capacity (min)	Material of Construction
23.1	Sludge feed pumps	Three (3X50%)	Vertical sump pump	15 cum/hr (min) each	Shaft, Coupling & sleeves- SS 410 Impeller – ASTM A 351 CF8M Suction bell/Casing – 2.5% Ni CI IS 210 Gr. FG 260, S-0.1% max. P-0.15 % max. Column & discharge pipe-IS 2062 or Eqv.
23.2	Sludge disposal pumps	Three (3X50%)	Single Screw Horizontal pump	5 CuM/Hr. (each).	Casing – IS:210 FG 260. Rotor,Stator,shaft,other rotating parts-SS316
23.3	Sludge transfer pumps	Two (2X10%)	Single Screw Horizontal pump	10 CuM/Hr. (each).	Casing – IS:210 FG 260. Rotor,Stator,shaft,other rotating parts-SS316
23.4	Gravity Filter Back wash water pumps	Three (2X100%)	Vertical sump pump (Suitable to handle Drains with particle size up to 40 mm)	Each pump shall be capable of evacuating the capacity of complete pit within 1 hours.	Shaft, Coupling & sleeves- SS 410 Impeller – ASTM A 351 CF8M Suction bell/Casing – 2.5% Ni CI IS 210 Gr. FG 260, S-0.1% max. P-0.15 % max. Column & discharge pipe-IS 2062 or Eqv.
23.5	Supernatant transfer pumps	Two (2X100%)	Vertical sump pump	25 Cu.M/hr (min).Each.	Shaft, Coupling & sleeves- SS 410 Impeller – ASTM A 351 CF8M Suction bell/Casing – 2.5% Ni CI IS 210 Gr. FG 260, S-0.1% max. P-0.15 % max. Column & discharge pipe-IS 2062 or Eqv.
23.6	Potable Water Pumps (Plant)	Two (2X100%)	Vertical Turbine (Wet pit) Type	20 m3/hr (min.).each	Shaft, Coupling & sleeves- SS 410 Impeller – ASTM A 351 CF8M Suction bell/Casing – 2.5% Ni CI IS 210 Gr. FG 260, S-0.1% max. P-0.15 % max. Column & discharge pipe-Fabricated steel as per IS: 2062 (minimum thickness shall not be less than 8 mm) with 2 coats of epoxy coating inside & outside.
23.7	Potable Water Pumps (Colony)	Two (2X100%)	Vertical Turbine (Wet pit) Type	75 m3/hr (min.) each	Shaft, Coupling & sleeves- SS 410 Impeller – ASTM A 351 CF8M Suction bell/Casing – 2.5% Ni CI IS 210 Gr. FG 260, S-0.1% max. P-0.15 % max. Column & discharge pipe-Fabricated steel as per IS: 2062 (minimum thickness shall not be less than 8 mm) with 2 coats of epoxy coating inside & outside.

24.	**VALVES**	As specified elsewhere in this specification.
25.	**PIPING**	
25.1	Raw water & Clarified water	Carbon Steel: IS: 1239 Part-I (Heavy grade-Black), ASTM-A-53 Type-E Grade B / ASTM A 36 /IS: 3589 - Grade 410; / IS-2062 Gr.-B (for fabricated from plates) / Equivalent
25.2	Filtered water	Stainless Steel: Stainless Steel ASTM A 312 Gr.304 Sch. 40 /Equivalent Seamless for Sizes 50 and above and welded for sizes 65 mm NB and above.
25.3	Coagulant (Alum) PAC Solution	Rubber lined Steel/CPVC Schedule 80 CPVC Schedule 80
25.4	Lime slurry/Solution/ Suspensions	CPVC as per ASTM F441 CPVC 4120 Sch. 80
25.5	Coagulant aid Solution	Rubber lined Steel (as refereed above)/CPVC as per ASTM F441 CPVC 4120, Schedule80/equivalent.
25.6	Sludge	1) GRP as per ASTM D3517/ AWWA C950-88/AWWA M45 2) HDPE as per ASTM D3350 CL 34543C, FM Class 150/ IS:4984 or Equivalent for buried portion
25.7	Chemical Waste from vessels and tanks	1) Rubber lined Steel (as referred above) 2) HDPE as per ASTM D3350 CL 34543C, FM Class 150/ IS: 4984 or Equivalent for buried portion.

SECTION-C2
(SPECIFIC TECHNICAL REQUIRMENT-ELECTRICAL)

TECHNICAL SPECIFICATION

FOR

DM PLANT/ CW TREATMENT/ PRE TREATMENT PLANT/EFFLUENT TREATMENT PLANT/ GAS CHLORINATION PLANT/SEWAGE TREAMENT PLANT

(ELECTRICAL PORTION)

1.0 **EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER:**

a) Services and equipment as per "Electrical Scope between BHEL and Vendor".
b) Any item/work either supply of equipment or erection material which have not been specifically mentioned but are necessary to complete the work for trouble free and efficient operation of the plant shall be deemed to be included within the scope of this specification. The same shall be provided by the bidder without any extra charge.
c) Supply of mandatory spares as specified in the specifications of mechanical equipments.
d) Electrical load requirement for **DM PLANT/ CW TREATMENT/ PRE TREATMENT PLANT/EFFLUENT TREATMENT PLANT/ GAS CHLORINATION PLANT/SEWAGE TREAMENT PLANT.**
e) All equipment shall be suitable for the power supply fault levels and other climatic conditions mentioned in the enclosed project information.
f) Bidder to furnish list of makes for each equipment at contract stage, which shall be subject to customer/BHEL approval without any commercial and delivery implications to BHEL
g) Various drawings, data sheets as per required format, Quality plans, calculations, test reports, test certificates, operation and maintenance manuals etc shall be furnished as specified at contract stage. All documents shall be subject to customer/BHEL approval without any commercial implication to BHEL.
h) Motor shall meet minimum requirement of motor specification.

2.0 **EQUIPMENT & SERVICES TO BE PROVIDED BY PURCHASER FOR ELECTRICAL & TERMINAL POINTS:**

Refer "Electrical Scope between BHEL and Vendor".

3.0 DOCUMENTS TO BE SUBMITTED ALONG WITH BID

3.1 Bidder shall confirm total compliance to the electrical specification without any deviation from the technical/quality assurance requirements stipulated. In line with this two signed and stamped copies of the following shall be furnished by the bidder as technical offer:

a) A copy of this sheet "Electrical equipment Specification for **DM PLANT/ CW TREATMENT/ PRE TREATMENT PLANT/EFFLUENT TREATMENT PLANT/ GAS CHLORINATION PLANT/SEWAGE TREAMENT PLANT**." and "Electrical Scope between BHEL and Vendor" with bidder's signature and company stamp.
b) Electrical load requirement

3.2 No technical submittal such as copies of data sheets, drawings, write-up, quality plans, type test certificates, technical literature, etc, is required during tender stage. Any such submission even if made, shall not be considered as part of offer.

4.0 List of enclosures :

a) Electrical scope between BHEL & vendor (Annexure –I)
b) Technical specification for motors.
c) Datasheets & quality plan for motors.
d) Provenness & Technical specification for control cables
e) Datasheets & quality plan for control cables
f) Technical specification for Screened control cables
g) Datasheets & quality plan for Screened control cables
h) Electrical Load data format (Annexure –II)
i) BHEL cable listing format (Annexure –III)
j) Electrical mandatory spares (Annexure IV)

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR(FOR EPC PROJECTS)

PACKAGES : VENTILATION / AC / MRS/ DM/ PTP/ CHLORINATION/ ETP/ CPU/ CWTP/STP
SCOPE OF VENDOR: SUPPLY, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT
PROJECT:

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	415V MCC	BHEL	BHEL	240 V AC (supply feeder)/415 V AC (3 PHASE 4 WIRE) supply shall be provided by BHEL based on load data provided by vendor at contract stage for all equipment supplied by vendor as part of contract. Any other voltage level (AC/DC) required will be derived by the vendor. OR (DE to select the choice applicable for their project)) 415 V AC, 3 phase, 3 wire supply shall be provided by BHEL based on load data provided by vendor at contract stage for all equipment supplied by vendor as part of contract. Any other voltage level (AC/DC) required will be derived by the vendor.
2	Local Push Button Station (for motors)	BHEL	BHEL	Located near the motor.
3	Power cables, control cables and screened control cables for a) both end equipment in BHEL's scope b) both end equipment in vendor's scope c) one end equipment in vendor's scope	 BHEL BHEL BHEL	 BHEL Vendor BHEL	1. For 3.b) & c): Sizes of cables required shall be informed by vendor at contract stage (based on inputs provided by BHEL) in the form of cable listing. Finalisation of cable sizes shall be done by BHEL. Vendor shall provide lugs & glands accordingly. 2. Termination at BHEL equipment terminals by BHEL. 3. Termination at Vendor equipment terminals by Vendor.
4	Junction box for control & instrumentation cable	Vendor	Vendor	Number of Junction Boxes shall be sufficient and positioned in the field to minimize local cabling (max 10-12 mtrs) and trunk cable.
5	Any special type of cable like compensating, co-axial, prefab, MICC, optical fibre etc.	Vendor	Vendor	Refer C&I portion of specification for scope of fibre Optical cables if used between PLC/ microprocessor & DCS.
6	Cable trays, accessories & cable trays supporting system 100/ 50 mm cable trays/ Conduits/ Galvanised steel cable troughs for local cabling	BHEL Vendor	BHEL Vendor	Local cabling from nearby main route cable tray (BHEL scope) to equipment terminal (vendor's scope) shall be through 100/ 50 mm. cable trays/ conduits/ Galvanised steel cable troughs, as per approved layout drawing during contract stage.
7	Cable glands ,lugs and bimetallic strip for equipment supplied by Vendor	Vendor	Vendor	1. Double compression Ni-Cr plated brass cable glands 2. Solder less crimping type heavy duty tinned copper lugs for power and

Shweta Gaba 09/03/15

Ravi Dutt 09/3/15

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR(FOR EPC PROJECTS)

PACKAGES : VENTILATION / AC / MRS/ DM/ PTP/ CHLORINATION/ ETP/ CPU/ CWTP/STP

SCOPE OF VENDOR: SUPPLY, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT

PROJECT:

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
				control cables.
8	Conduit and conduit accessories for cabling between equipment supplied by vendor	Vendor	Vendor	Conduits shall be medium duty, hot dip galvanised cold rolled mild steel rigid conduit as per IS: 9537.
9	Lighting	BHEL	BHEL	
10	Equipment grounding (including electronic earthing) & lightning protection	BHEL	BHEL	Refer note no. 4 for electronic earthing
11	Below grade grounding	BHEL	BHEL	
12	LT Motors with base plate and foundation hardware	Vendor	Vendor	Makes shall be subject to customer/ BHEL approval at contract stage.
13	Mandatory spares	Vendor	-	Vendor to quote as per specification.
14	Recommended O & M spares	Vendor	-	As specified elsewhere in specification
15	Any other equipment/ material/ service required for completeness of system based on system offered by the vendor (to ensure trouble free and efficient operation of the system).	Vendor	Vendor	
16	a) Input cable schedules (Control & Screened Control Cables) b) Cable interconnection details for above c) Cable block diagram	Vendor Vendor Vendor	- - -	Cable listing for Control and Instrumentation Cable and electronic earthing cable in enclosed excel format shall be submitted by vendor during detailed engineering stage.
17	Electrical Equipment & cable tray layout drawings	Vendor	-	For ensuring cabling requirements are met, vendor shall furnish Electrical equipment layout & cable tray layout drawings (both in print form as well as in AUTOCAD) of the complete plant (including electrical area) indicating location and identification of all equipment requiring cabling, and shall incorporate cable trays routing details marked on the drawing as per PEM interface comments. Cabling arrangement of the same (wherever overhead cable trays, trenches, cable ducts, conduits etc.) shall be decided during contract stage. Electrical equipment layout & cable tray layout drawing shall be subjected to BHEL/ customer approval without any commercial implications to BHEL.

Shweta Gaba 09/03/15

Pravan Dalal 09/3/2015

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR(FOR EPC PROJECTS)

PACKAGES : VENTILATION / AC / MRS/ DM/ PTP/ CHLORINATION/ ETP/ CPU/ CWTP/STP

SCOPE OF VENDOR: SUPPLY, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT

PROJECT:

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
18	Electrical Equipment GA drawing	Vendor	-	For necessary interface review.

NOTES:

1. Make of all electrical equipment/ items supplied shall be reputed make & shall be subject to approval of BHEL/customer after award of contract.
2. All QPs shall be subject to approval of BHEL/customer after award of contract without any commercial implication.
3. In case the requirement of Junction Box arises on account of Power Cable size mis-match due to vendor engineering at later stage, vendor shall supply the Junction Box for suitable termination.
4. Vendor shall indicate location of Electronic Earth pit in their Civil assignment drawing.

Shweta Gaba
09/03/15

Pawan Dutt
09/3/2015

LOAD TITLE	RATING (KW / A)		UNIT (U)/STN (S)	Nos.		VOLTAGE CODE*	FEEDER CODE**	EMER. LOAD (Y)	CONT.(C)/ INTT.(I)	STARTING TIME >5 SEC (Y)	LOCATION	BOARD NO.	CABLE		BLOCK CABLE DRG. No.	CONTROL CODE	REMARKS	LOAD No.
	NAME PLATE	MAX. CONT. DEMAND (MCR)		RUNNING	STANDBY								SIZE CODE	NOs				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19

ANNEXURE-II

NOTES: 1. COLUMN 1 TO 12 & 18 SHALL BE FILLED BY THE REQUISITIONER (ORIGINATING AGENCY); REMAINING COLUMNS ARE TO BE FILLED UP BY PEM (ELECTRICAL)/ CUSTOMER

2. ABBREVIATIONS : * VOLTAGE CODE (7):- (ac) A=11 KV, B=6.6 KV, C=3.3 KV, D=415 V, E=240 V (1 PH), F=110 V (cc): G=220 V, H=110 V, J=48 V, K=+24V, L=-24 V

: ** FEEDER CODE (8):- U=UNIDIRECTIONAL STARTER, B=BI-DIRECTIONAL STARTER, S=SUPPLY FEEDER, D=SUPPLY FEEDER (CONTACTER CONTROLLED)

LOAD DATA (ELECTRICAL)	JOB NO.	434	ORIGINATING AGENCY		PEM (ELECTRICAL)
	PROJECT TITLE	3x800MW PATRATU STPP	NAME		DATA FILLED UP ON
	SYSTEM	ELEVATORS	SIGN.		DATA ENTERED ON
	DEPTT. / SECTION	MAUX	SHEET 1 OF 1	REV. 00	DE'S SIGN. & DATE

SUB–SECTION – B-07

MOTORS

MOTORS

1.00.00 GENERAL REQUIREMENTS

1.01.00 For the purpose of design of equipment/systems, an ambient temperature of 50 deg. Centigrade and relative humidity of 95% (at 40 deg C) shall be considered. The equipment shall operate in a highly polluted environment.

1.02.00 All equipment shall be suitable for rated frequency of 50 Hz with a variation of +3% & -5%, and 10% combined variation of voltage and frequency unless specifically brought out in the specification.

1.03.00 Contractor shall provide fully compatible electrical system, equipment, accessories and services.

1.04.00 All the equipment, material and systems shall, in general, conform to the latest edition of relevant National and international Codes & Standards, especially the Indian Statutory Regulations.

1.05.00 Paint shade shall be as per RAL 5012 (Blue) for indoor and outdoor equipment.

1.06.00 The responsibility of coordination with electrical agencies and obtaining all necessary clearances for contractors equipment and systems shall be under the contractor scope.

1.07.00 Degree of Protection

Degree of protection for various enclosures as per IEC60034-05 shall be as follows:-

i)	Indoor motors	-	IP 54
ii)	Outdoor motors	-	IP 55
iii)	Cable box-indoor area	-	IP 54
iv)	Cable box-Outdoor area	-	IP 55

2.00.00 CODES AND STANDARDS

1)	Three phase induction motors	:	IS/IEC:60034
2)	Single phase AC motors	:	IS/IEC:60034
3)	Crane duty motors	:	IS:3177, IS/IEC:60034
4)	DC motors/generators	:	IS/IEC:60034
5)	Energy Efficient motors	:	IS 12615, IEC: 60034-30

CLAUSE NO.	TECHNICAL REQUIREMENTS
3.00.00	**TYPE**
3.01.00	**AC Motors:** a) Squirrel cage induction motor suitable for direct-on-line starting. b) Continuous duty LT motors upto 200 KW Output rating (at 50 deg.C ambient temperature), shall be Premium Efficiency class-IE3, conforming to IS 12615, or IEC:60034-30. c) Crane duty motors shall be squirrel cage Induction motor as per the requirement. d) Motor operating through variable frequency drives shall be suitable for inverter duty. Also these motors shall comply the requirements stipulated in IEC: 60034-18-41 and IEC: 60034-18-42 as applicable.
3.02.00	DC Motors Shunt wound
4.00.00	**RATING** (a) Continuously rated (S1). However, crane motors shall be rated for S4 duty, 40% cyclic duration factor. (b) Whenever the basis for motor or driven equipment ratings are not specified in the corresponding mechanical specification sub-sections, maximum continuous motor ratings shall be at least 10% above the maximum load demand of the driven equipment under entire operating range including voltage and frequency variations. (c) For BFP motors, starting MVA shall be restricted to meet requirements indicated in B-0. (d) The starting current for the DC motors shall be restricted to 3 times of the full load current.
5.00.00	**TEMPERATURE RISE** **Air cooled motors** 70 deg. C by resistance method for both thermal class 130(B) & 155(F) insulation. **Water cooled** 80 deg. C over inlet cooling water temperature mentioned elsewhere, by resistance method for both thermal class 130(B) & 155(F) insulation.

	41 deg.C over inlet cooling water maximum temperature of 39 deg.C for thermal class 90 (Y) wet wound Boiler circulation pump motor.
6.00.00	**OPERATIONAL REQUIREMENTS**
6.01.00	**Starting Time**
6.01.01	For motors with starting time upto 20 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 2.5 secs. more than starting time.
6.01.02	For motors with starting time more than 20 secs. and upto 45 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 5 secs. more than starting time.
6.01.03	For motors with starting time more than 45 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be more than starting time by at least 10% of the starting time.
6.01.04	Speed switches mounted on the motor shaft shall be provided in cases where above requirements are not met.
6.02.00	**Torque Requirements**
6.02.01	Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10% motor full load torque.
6.02.02	Pull out torque at rated voltage shall not be less than 205% of full load torque. It shall be 275% for crane duty motors.
6.03.00	**Starting voltage requirement** (a) Up to 85% of rated voltage for ratings below 110 KW (b) Up to 80% of rated voltage for ratings from 110 KW to 200 KW (c) Up to 85% of rated voltage for ratings from 201 KW to 1000 KW (d) Up to 80% of rated voltage for ratings from 1001 KW to 4000 KW (e) Up to 75 % of rated voltage for ratings above 4000KW Except AOP & JOP motors running on D.G emergency supply, starting voltage shall be 80%.

CLAUSE NO.	TECHNICAL REQUIREMENTS
7.00.00	**DESIGN AND CONSTRUCTIONAL FEATURES**
7.01.00	Suitable single phase space heaters shall be provided on motors rated 30KW and above to maintain windings in dry condition when motor is standstill. Separate terminal box for space heaters & RTDs shall be provided. However for flame proof motors, space heater terminals inside the main terminal box may be acceptable.
7.02.00	All motors shall be either Totally enclosed fan cooled (TEFC) or totally enclosed tube ventilated (TETV) or Closed air circuit air cooled (CACA) type. However, motors rated 3000KW or above can be Closed air circuit water cooled (CACW). The method of movement of primary and secondary coolant shall be self-circulated by fan or pump directly mounted on the rotor of the main motor as per IEC 60034-6. However VFD driven motors can be offered with forced cooling type with machine mounted fan or pump driven by separate electric motor. Motors and EPB located in hazardous areas shall have flame proof enclosures conforming to IS: 2148 as detailed below (a) Fuel oil area : Group – IIB (b) Hydrogen generation : Group - IIC or (Group-I, Div-II as per plant area NEC) or (Class-1, Group-B, Div-II as per NEMA / IEC60034)
7.03.00	Winding and Insulation (a) Type : Non-hygroscopic, oil resistant, flame resistant (b) Starting duty : Two hot starts in succession, with motor initially at normal running temperature. (c) 11kV & 3.3 kV AC motors : Thermal class 155 (F) insulation. The winding insulation process shall be total Vacuum Pressure Impregnated i.e. resin poor method. The lightning Impulse & intertern insulation surge withstand level shall be as per IEC-60034 part-15. However winding insulation for wet wound Boiler circulation pump motor shall be thermal class 90 (Y) or better. (d) 240VAC, 415V AC & 220V DC motors : Thermal Class (B) or better
7.04.00	Motors rated above 1000KW shall have insulated bearings to prevent flow of shaft currents.

CLAUSE NO.	TECHNICAL REQUIREMENTS
7.05.00	Motors with heat exchangers shall have dial type thermometer with adjustable alarm contacts to indicate inlet and outlet primary air temperature.
7.06.00	Noise level for all the motors shall be limited to 85dB (A) except for BFP motor for which the maximum limit shall be 90 dB(A). Vibration shall be limited within the limits prescribed in IS/IEC 60034-14. Motors shall withstand vibrations produced by driven equipment. HT motor bearing housings shall have flat surfaces, in both X and Y directions, suitable for mounting 80mmX80mm vibration pads.
7.07.00	In HT motors, at least four numbers simplex / two numbers duplex platinum resistance type temperature detectors shall be provided in each phase stator winding. Each bearing of HT motor shall be provided with dial type thermometer with adjustable alarm contact and preferably 2 numbers duplex platinum resistance type temperature detectors.
7.08.00	Motor body shall have two earthing points on opposite sides.
7.09.00	11 KV motors shall be offered with Separable Insulated Connector (SIC) as per IEEE 386. The offered SIC terminations shall be provided with protective cover and trifurcating sleeves. SIC termination kit shall be suitable for fault level of 25 KA for 0.17 seconds.
7.10.00	3.3 KV motors shall be offered with dust tight phase separated double walled (metallic as well as insulated barrier) Terminal box. Suitable termination kit shall be provided for the offered Terminal box. The offered Terminal Box shall be suitable for fault level of 250 MVA for 0.12 sec. Removable gland plates of thickness 3 mm (hot/cold rolled sheet steel) or 4 mm (non-magnetic material for single core cables) shall be provided.
7.11.00	The spacing between gland plate & center of terminal stud shall be as per Table-I.
7.12.00	All motors shall be so designed that maximum inrush currents and locked rotor and pullout torque developed by them at extreme voltage and frequency variations do not endanger the motor and driven equipment.
7.13.00	The motors shall be suitable for bus transfer schemes provided on the 11kV, 3.3 kV /415V systems without any injurious effect on its life.
7.14.00	For motors rated 2000 KW & above, neutral current transformers of PS class shall be provided on each phase in a separate neutral terminal box.
7.15.00	The size and number of cables (for HT and LT motors) to be intimated to the successful bidder during detailed engineering and the contractor shall provide terminal box suitable for the same.

CLAUSE NO.	TECHNICAL REQUIREMENTS
8.00.00	The ratio of locked rotor KVA at rated voltage to rated KW shall not exceed the following (without any further tolerance) except for BFP motor. (a) Below 110KW : 11.0 (b) From 110 KW & upto 200 KW : 9.0 (c) Above 200 KW & upto 1000KW : 10.0 (d) From 1001KW & upto 4000KW : 9.0 (e) Above 4000KW : 6 to 6.5
9.00.00	CW motor shall be designed with minimum power factor of 0.8 at design duty point.
10.00.00	**TYPE TEST**
10.01.00	**HT MOTORS**
10.01.01	The contractor shall carry out the type tests as listed in this specification on the equipment to be supplied under this contract. The bidder shall indicate the charges for each of these type tests separately in the relevant schedule of Section - VII-(BPS) and the same shall be considered for the evaluation of the bids. The type tests charges shall be paid only for the test(s) actually conducted successfully under this contract and upon certification by the employer's engineer.
10.01.02	The type tests shall be carried out in presence of the employer's representative, for which minimum 15 days notice shall be given by the contractor. The contractor shall obtain the employer's approval for the type test procedure before conducting the type test. The type test procedure shall clearly specify the test set–up, instruments to be used, procedure, acceptance norms, recording of different parameters, interval of recording, precautions to be taken etc. for the type test(s) to be carried out.
10.01.03	In case the contractor has conducted such specified type test(s) within last ten years as on the date of bid opening, he may submit during detailed engineering the type test reports to the employer for waival of conductance of such test(s). These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. The employer reserves the right to waive conducting of any or all the specified type test(s) under this contract. In case type tests are waived, the type test charges shall not be payable to the contractor.
10.01.04	Further the Contractor shall only submit the reports of the type tests as listed in "LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED "and carried out within last ten years from the date of bid opening. These reports should be for

the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. However if the contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the employer either at third party lab or in presence of client/ employer's representative and submit the reports for approval.

10.01.05 **LIST OF TYPE TESTS TO BE CONDUCTED**

The following type tests shall be conducted on each type and rating of HT motor

(a) No load saturation and loss curves upto approximately 115% of rated voltage

(b) Measurement of noise at no load.

(c) Momentary excess torque test (subject to test bed constraint).

(d) Full load test (subject to test bed constraint)

(e) Temperature rise test at rated conditions. During heat run test, bearing temp., winding temp., coolant flow and its temp. shall also be measured. In case the temperature rise test is carried at load other than rated load, specific approval for the test method and procedure is required to be obtained. Wherever ETD's are provided, the temperature shall be measured by ETD's also for the record purpose.

10.01.06 **LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED**

The following type test reports shall be submitted for each type and rating of HT motor

(a) Degree of protection test for the enclosure followed by IR, HV and no load run test.

(b) Terminal box-fault level withstand test for each type of terminal box of HT motors only.

(c) Lightning Impulse withstand test on the sample coil shall be as per clause no. 4.3 IEC-60034, part-15

(d) Surge-withstand test on interturn insulation shall be as per clause no. 4.2 of IEC 60034, part-15

CLAUSE NO.	TECHNICAL REQUIREMENTS
10.02.00	**LT Motors**
10.02.01	LT Motors supplied shall be of type tested design. During detailed engineering, the contractor shall submit for employer's approval the reports of all the type tests as listed in this specification and carried out within last *ten* years from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.
10.02.02	However if the contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the employer either at third party lab or in presence of client/ employer's representative and submit the reports for approval.
10.02.03	**LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED** **The following type test reports shall be submitted for each type and rating of LT motor of above 50 KW only** 1. Measurement of resistance of windings of stator and wound rotor. 2. No load test at rated voltage to determine input current power and speed 3. Open circuit voltage ratio of wound rotor motors (in case of Slip ring motors) 4. Full load test to determine efficiency power factor and slip. 5. Temperature rise test. 6. Momentary excess torque test. 7. High voltage test. 8. Test for vibration severity of motor. 9. Test for noise levels of motor(Shall be limited as per clause no 7.06.00 of this section) 10. Test for degree of protection and 11. Over speed test.

12. Type test reports for motors located in fuel oil area having flame proof enclosures as per IS 2148 / IEC 60079-1

10.03.00 All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.

10.04.00 The type test reports once approved for any projects shall be treated as reference. For subsequent projects of NTPC, an endorsement sheet will be furnished by the manufacturer confirming similarity and "No design Change". Minor changes if any shall be highlighted on the endorsement sheet.

TABLE - I

DIMENSIONS OF TERMINAL BOXES FOR LV MOTORS

Motor MCR in KW	**Minimum distance between centre of stud and gland plate in mm**
UP to 3 KW	**As per manufacturer's practice.**
Above 3 KW - upto 7 KW	85
Above 7 KW - upto 13 KW	115
Above 13 KW - upto 24 KW	167
Above 24 KW - upto 37 KW	196
Above 37 KW - upto 55 KW	249
Above 55 KW - upto 90 KW	277
Above 90 KW - upto 125 KW	331
Above 125 KW-upto 200 KW	203

For HT motors the distance between gland plate and the terminal studs shall not be less than 500 mm.

PHASE TO PHASE/ PHASE TO EARTH AIR CLEARANCE:

NOTE: Minimum inter-phase and phase-earth air clearances for LT motors with lugs installed shall be as follows:

Motor MCR in KW	Clearance
UP to 110 KW	10mm
Above 110 KW and upto 150 KW	12.5mm
Above 150 KW	19mm

MOTOR

TESTS/CHECKS / TEMS/COMPONENTS	Visual	Dimensional	Make/Type/Rating /General Physical Inspection	Mech/Chem. Properties	NDT /DP/MPI/UT	Metallography	Electrical Characteristics	Welding/Brazing(WPS/PQR)	Heat Treatment
Plates for stator frame, end shield, spider etc.	Y	Y	Y	Y	Y				Y
Shaft	Y	Y	Y	Y	Y	Y			Y
Magnetic Material	Y	Y	Y	Y			Y		
Rotor Copper/Aluminium	Y	Y	Y	Y			Y		Y
Stator copper	Y	Y	Y	Y			Y		Y
SC Ring	Y	Y	Y	Y	Y		Y	Y	Y
Insulating Material	Y		Y	Y			Y		
Tubes, for Cooler	Y	Y	Y	Y	Y				Y
Sleeve Bearing	Y	Y	Y	Y	Y				Y
Stator/Rotor, Exciter Coils	Y	Y	Y				Y	Y	
Castings, stator frame, terminal box and bearing housing etc.	Y	Y	Y	Y	Y			Y	
Fabrication & machining of stator, rotor, terminal box	Y	Y			Y			Y	Y
Wound stator	Y	Y					Y	Y	
Wound Exciter	Y	Y					Y	Y	
Rotor complete	Y	Y					Y		
Exciter, Stator, Rotor, Terminal Box assembly	Y	Y					Y		
Accessories, RTD, BTD,CT, Space heater, antifriction bearing, gaskets etc.	Y	Y	Y						
Complete Motor	Y	Y	Y						

Note:
1. This is an indicative list of tests/checks. The manufacture is to furnish a detailed Quality Plan indicating the practices & Procedure followed along with relevant supporting documents during QP finalization. However, No QP for LT motor upto 50KW.
2. Additional routine tests for Flame proof motors shall be applicable as per relevant standard
3. Makes of major bought out items for HT motors will be subject to NTPC approval.

Y1 = for HT Motor / Machines only.

MOTOR

TESTS/CHECKS / ITEMS/ COMPONENTS	Magnetic Characteristics	Hydraulic/Leak/Pressure Test	Thermal Characteristics	Run out	Dynamic Balancing	Routine & Acceptance tests as per IS-325/IS-4722 /IS- 9283/IS 2148/IEC60034\IEC 60079-I	vibration	Over speed	Tan delta, shaft voltage & polarization index test	Paint shade, thickness & adhesion
Plates for stator frame, end shield, spider etc.										
Shaft										
Magnetic Material	Y		Y							
Rotor Copper/Aluminium										
Stator copper			Y							
SC Ring										
Insulating Material			Y							
Tubes for Cooler		Y								
Sleeve Bearing		Y								
Stator/Rotor, Exciter Coils										
Castings, stator frame, terminal box and bearing housing etc.										
Fabrication & machining of stator, rotor, terminal box										
Wound stator										
Wound Exciter										
Rotor complete				Y	Y					
Exciter, Stator, Rotor, Terminal Box assembly										
Accessories, RTD, BTD,CT, , Space heater, antifriction bearing, gaskets etc.										
Complete Motor						Y	Y	Y	Y1	Y

Note: 1. This is an indicative list of tests/checks. The manufacture is to furnish a detailed Quality Plan indicating the practices & Procedure followed along with relevant supporting documents during QP finalization. However, No QP for LT motor upto 50KW.

2. Additional routine tests for Flame proof motors shall be applicable as per relevant standard

3. Makes of major bought out items for HT motors will be subject to NTPC approval.

Y1 = for HT Motor / Machines only.

GENERAL TECHNICAL REQUIREMENTS

FOR

LV MOTORS

SPECIFICATION NO.: PE-SS-999-506-E101 Rev 00

1.0 INTENT OF SPECIFIATION

The specification covers the design, materials, constructional features, manufacture, inspection and testing at manufacturer's work, and packing of Low voltage (LV) squirrel cage induction motors along with all accessories for driving auxiliaries in thermal power station.

Motors having a voltage rating of below 1000V are referred to as low voltage (LV) motors.

2.0 CODES AND STANDARDS

Motors shall fully comply with latest edition, including all amendments and revision, of following codes and standards:

IS:325	Three phase Induction motors
IS : 900	Code of practice for installation and maintenance of induction motors
IS: 996	Single phase small AC and universal motors
IS: 4722	Rotating Electrical machines
IS: 4691	Degree of Protection provided by enclosures for rotating electrical machines
IS: 4728	Terminal marking and direction of rotation rotating electrical machines
IS: 1231	Dimensions of three phase foot mounted induction motors
IS: 8789	Values of performance characteristics for three phase induction motors
IS: 13555	Guide for selection and application of 3-phase A.C. induction motors for different types of driven equipment
IS: 2148	Flame proof enclosures for electrical appliance
IS: 5571	Guide for selection of electrical equipment for hazardous areas
IS: 12824	Type of duty and classes of rating assigned
IS: 12802	Temperature rise measurement ofr rotating electrical machnines
IS: 12065	Permissible limits of noise level for rotating electrical machines
IS: 12075	Mechnical vibration of rotatinf electrical machines

In case of imported motors, motors as per IEC-34 shall also be acceptable.

3.0 DESIGN REQUIREMENTS

3.1 Motors and accessories shall be designed to operate satisfactorily under conditions specified in data sheet-A and Project Information, including voltage & frequency variation of supply system as defined in Data sheet-A

3.2 Motors shall be continuously rated at the design ambient temperature specified in Data Sheet-A and other site conditions specified under Project Information
Motor ratings shall have at least a 15% margin over the continuous maximum demand of the driven equipment, under entire operating range including voltage & frequency variation specified above.

3.3 Starting Requirements

3.3.1 Motor characteristics such as speed, starting torque, break away torque and starting time shall be properly co-ordinated with the requirements of driven equipment. The accelerating torque at any speed with the minimum starting voltage shall be at least 10% higher than that of the driven equipment.

3.3.2 Motors shall be capable of starting and accelerating the load with direct on line starting without exceeding acceptable winding temperature.

The limiting value of voltage at rated frequency under which a motor will successfully start and accelerate to rated speed with load shall be taken to be a constant value as per Data Sheet - A during the starting period of motors.

3.3.3 The following frequency of starts shall apply

i) Two starts in succession with the motor being initially at a temperature not exceeding the rated load temperature.

ii) Three equally spread starts in an hour the motor being initially at a temperature not exceeding the rated load operating temperature. (not to be repeated in the second successive hour)

iii) Motors for coal conveyor and coal crusher application shall be suitable fro three consecutive hot starts followed by one hour interval with maximum twenty starts per day and shall be sutable fro mimimum 20,000 starts during the life time of the motor

3.4 **Running Requirements**

3.4.1 Motors shall run satisfactorily at a supply voltage of 75% of rated voltage for 5 minutes with full load without injurious heating to the motor.

3.4.2 Motor shall not stall due to voltage dip in the system causing momentary drop in voltage upto 70% of the rated voltage for duration of 2 secs.

3.5 **Stress During bus Transfer**

3.5.1 Motors shall withstand the voltage, heavy inrush transient current, mechnical and torque stress developed due to the application of 150% of the rated voltage for at least 1 sec. caused due to vector difference between the motor residual voltage and the incoming supply voltage during occasional auto bus transfer.

3.5.2 Motor and driven equipment shafts shall be adequately sized to satisfactorily withstand transient torque under above condition.

3.6 Maximum noise level measured at distance of 1.0 metres from the outline of motor shall not exceed the values specified in IS 12065.

3.7 The max. vibration velocity or double amplitude of motors vibration as measured at motor bearings shall be within the limits specified in IS: 12075.

4.0 **CONSTRUCTIONAL FEATURES**

4.1 Indoor motors shall conform to degree of protection IP: 54 as per IS: 4691. Outdoor or semi-indoor motors shall conform to degree of protection IP: 55 as per IS: 4691and shall be of weather-proof construction. Outdoor motors shall be installed under a suitable canopy

4.2 Motors upto 160KW shall have Totally Enclosed Fan Cooled (TEFC) enclosures, the method of cooling conforming to IC-0141 or IC-0151 of IS: 6362.

Motors rated above 160 KW shall be Closed Air Circuit Air (CACA) cooled

4.3 Motors shall be designed with cooling fans suitable for both directions of rotation.

4.4. Motors shall not be provided with any electric or pneumatic operated external fan for cooling the motors.

4.5 Frames shall be designed to avoid collection of moisture and all enclosures shall be provided with facility for drainage at the lowest point.

4.6 In case Class 'F' insulation is provided for LV motors, temperature rise shall be limited to the limits applicable to Class 'B' insulation.
In case of continuous operation at extreme voltage limits the temperature limits specified in table-1 of IS:325 shall not exceed by more than 10°C.

4.7 **Terminals and Terminal Boxes**

4.7.1 Terminals, terminal leads, terminal boxes, windings tails and associated equipment shall be suitable for connection to a supply system having a short circuit level, specified in the Data Sheet-A.

Unless otherwise statedin Data Sheet-A, motors of rating 110 kW and above will be controlled by circuit breaker and below 110 kW by switch fuse-contactor. The terminal box of motors shall be designed for the fault current mentioned in data sheet "A".

4.7.2 Unless otherwise specified or approved, phase terminal boxes of horizontal motors shall be positioned on the left hand side of the motor when viewed from the non-driving end.

4.7.3 Connections shall be such that when the supply leads R, Y & B are connected to motor terminals A B & C or U, V & W respectively, motor shall rotate in an anticlockwise direction when viewed from the non-driving end. Where such motors require clockwise rotation, the supply leads R, Y, B will be connected to motor terminals A, C, B or V W & V respectively.

4.7.4 Permanently attached diagram and instruction plate made preferably of stainless steel shall be mounted inside terminal box cover giving the connection diagram for the desired direction of rotation and reverse rotation.

4.7.5 Motor terminals and terminal leads shall be fully insulated with no bar live parts. Adequate space shall be available inside the terminal box so that no difficulty is encountered for terminating the cable specified in Data Sheet-A.

4.7.6 Degree of protection for terminal boxes shall be IP 55 as per IS 4691.

4.7.7 Separate terminal boxes shall be provided for space heaters.. If this is not possible in case of LV motors, the space heater terminals shall be adequately segregated from the main terminals in the main terminal box. Detachable gland plates with double compression brass glands shall be provided in terminal boxes.

4.7.8. Phase terminal boxes shall be suitable for 360 degree of rotation in steps of 90 degree for LV motors.

4.7.9 Cable glands and cable lugs as per cable sizes specified in Data Sheet-A shall be included. Cable lugs shall be of tinned Copper, crimping type.

4.8 Two separate earthing terminals suitable for connecting G.I. or MS strip grounding conductor of size given in Data Sheet-A shall be provided on opposite sides of motor frame. Each terminal box shall have a grounding terminal.

4.9 **General**

4.9.1 Motors provided for similar drives shall be interchangeable.

4.9.2 Suitable foundation bolts are to be supplied alongwith the motors.

4.9.3 Motors shall be provided with eye bolts, or other means to facilitate safe lifting if the weight is 20Kgs. and above.

4.9.4 Necessary fitments and accessories shall be provided on motors in accordance with the latest Indian Electricity rules 1956.

4.9.5 All motors rated above 30 kW shall be provided with space heaters to maintain the motor internal air temperature above the dew point. Unless otherwise specified, space heaters shall be suitable for a supply of 240V AC, single phase, 50 Hz.

4.9.6 Name plate with all particulars as per IS: 325 shall be provided

4.9.7 Unless otherwise specified, the colour of finish shall be grey to Shade No. 631 and 632 as per IS:5 for motors installed indoor and outdoor respectively. The paint shall be epoxy based and shall be suitable for withstanding specified site conditions.

5.0 **INSPECTION AND TESTING**

5.1 All materials, components and equipments covered under this specification shall be procured, manufactured, as per the BHEL standard quality plan No. PED-506-00-Q-006/0 and PED-506-00-Q-007/2 enclosed with this specification and which shall be complied.

5.2 LV motors of type-tested design shall be provided. Valid type test reports not more than 5 year shall be furnished. In the absence of these, type tests shall have to be conducted by manufacturer without any commercial implication to purchaser.

5.3 All motors shall be subjected to routine tests as per IS: 325 and as per BHEL standard quality plan.

5.4 Motors shall also be subjected to additional tests, if any, as mentioned in Data Sheet A.

6.0 **DRAWINGS TO BE SUBMITTED AFTER AWARD OF CONTRACT**

a) OGA drawing showing the position of terminal boxes, earthing connections etc.
b) Arrangement drawing of terminal boxes.
c) Characteristic curves:
(*To be given for motor above 55 kW unless otherwise specified in Data Sheet*).

i) Current vs. time at rated voltage and minimum starting voltage.
ii) Speed vs. time at rated voltage and minimum starting voltage.
iii) Torque vs. speed at rated voltage and minimum voltage.
For the motors with solid coupling the above curves i), ii), iii) to be furnished for the motors coupled with driven equipment. In case motor is coupled with mechanical equipment by fluid coupling, the above curves shall be furnished with and without coupling.
iv) Thermal withstand curve under hot and cold conditions at rated voltage and max. permissible voltage.

	TITLE	SPECIFICATION NO.
	LV MOTORS	VOLUME II B
		SECTION D
	DATA SHEET-A	REV NO. 00 DATE 01/10/2012
		SHEET 1 OF 1

1.0	Design ambient temperature	:	50 ºC
2.0	Maximum acceptable kW rating of LV motor	:	≤200KW
3.0	Installation (Indoors/ Outdoors)	:	As required
4.0	Degree Of Protection (Indoor/Outdoor)	:	IP54/IP55
5.0	Type of Cooling	:	TEFC/CACA/TETV
6.0	Details of supply system		
	a) Rated voltage (with variation)	:	415V ± 10%
	b) Rated frequency (with variation)	:	50 Hz (Variation: +3% TO –5%)
	c) Combined voltage & freq. variation	:	10%
	d) System fault level at rated voltage	:	50 kA for 1 sec
	e) Short time rating for terminal boxes		
	o 110kW & Above (Breaker controlled)	:	50 kA for 1 sec
	o Below 110kW (SFU+ Contactor controlled)	:	50 KA for 0.20 sec.
	f) LV System grounding	:	Solidly
7.0	Class of insulation	:	Class ‘F’, with temp rise limited to class B. (Refer clause 5.00.00 of Motors)
8.0	Minimum voltage for starting (As percentage of rated voltage)	:	As per Customer Motor Spec (enclosed)
9.0	Power cables data	:	Shall be given during Detailed engg.
10.0	Earth Conductor Size & Material	:	Shall be given during Detailed engg.
11.0	Space heater supply	:	240 V, 1Φ , 50 Hz
12.0	Rating up to which Single phase motor	:	Acceptable below 0.20 kW
13.0	Tests	:	As per Customer motor spec. (enclosed)
14.0	Energy efficient/ Flame proof motor	:	As per Customer spec. requirement

- **Also detail Customer spec. for Motors to be referred as enclosed with spec.**
- **The requirements mentioned in Customer Motor Spec for Motors shall prevail in case of conflict between the same and the corresponding requirements mentioned in the Section C/ Section D/ Datasheet A**

	TITLE	SPECIFICATION NO.
	MOTOR	**VOLUME II B**
		SECTION D
	DATA SHEET - C	**REV NO. 00 DATE 28.07.14**
		SHEET 1 **OF** 2

S. No.	Description	Data to be filled by successful bidder
A.	**General**	
1	Manufacturer & country of origin	
2	Motor type	
3	Type of starting	
4	Name of the equipment driven by motor & Quantity	
5	Maximum Power requirement of driven equipment	
6	Rated speed of Driven Equipment	
7	Design ambient temperature	
B.	**Design and Performance Data**	
1	Frame size & type designation	
2	Type of duty	
3	Rated Voltage	
4	Permissible variation for	
5	a Voltage	
6	b Frequency	
7	c) Combined voltage & frequency	
8	Rated output at design ambient temp (by resistance method)	
9	Synchronous speed & Rated slip	
10	Minimum permissible starting voltage	
11	Starting time in sec with mechanism coupled	
12	a) At rated voltage	
13	b) At min starting voltage	
14	Locked rotor current as percentage of FLC (including IS tolerance)	
15	Torque	
	a) Starting	
	b) Maximum	
16	Permissible temp rise at rated output over ambient temp & method	
17	Noise level at 1.0 m (dB	
18	Amplitude of vibration	
19	Efficiency & P.F. at rated voltage & frequency	
	a) At 100% load	
	c) At 75% load	

NAME OF VENDOR				REV.	
NAME	SIGNATURE	DATE	SEAL		

S. No.	Description	Data to be filled by successful bidder
	c) At starting	
C.	**Constructional Features**	
1	Method of connection of motor driven equipment	
2	Applicable Standard	
3	DOP of Enclosure	
4	Method of cooling	
5	Class of insulation	
6	Main terminal box	
	a) Type	
	b) Power Cable details (Conductor, size, armour/unarmour)	
	c) Cable Gland & lugs details (Size, type & material)	
	d) Permissible Fault level (kArms & duration in sec)	
7	Space heater details (Voltage & watts)	
8	Flame proof motor details (if applicable)	
	a) Enclosure	
	b) suitability for hazardous area	
	i Zone	O / I / II
	ii Group	IIA / IIB / IIC
9	No. of Stator winding	
10	Winding connection	
11	Kind of rotor winding	
12	Kind of bearings	
13	Direction of rotation when viewed from NDE	
14	Paint Shade & type	
15	Net weight of motor	
16	Outline mounting drawing No (To be enclosed as annexure)	
D.	**Characteristic curves/ drawings** (To be enclosed for motors of rating ≥ 55KW)	
	a) Torque speed characteristic	
	b) Thermal withstand characteristic	
	c) Current vs time	
	d) Speed vs time	

			CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
	QUALITY PLAN		BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 1 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.0	RAW MATERIAL & BOUGHT OUT CONTROL											
1.1	SHEET STEEL, PLATES, SECTION, EYEBOLTS	1.SURFACE CONDITION	MA	VISUAL	100%	-	FREE FROM BLINKS, CRACKS, WAVINESS ETC	LOG BOOK	3	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANFR'S DRG./SPEC	MANFR'S DRG./SPEC	-DO-	3	-	-	
		3.PROOF LOAD TEST (EYE BOLT)	MA	MECH. TEST	-DO-	-DO-	-DO-	INSPEC. REPORT	3	-	2	
1.2	HARDWARES	1.SURFACE CONDITION	MA	VISUAL	100%		FREE FROM CRACKS, UN-EVENNESS ETC.	-DO-	3	-	-	
		2.PROPERTY CLASS	MA	VISUAL	SAMPLES	MANFR'S DRG./SPEC BOOK	RELEVENT IS/SPEC.	SUPPLIERS TC & LOG	3	-	2	PROPERTY CLASS MARKING SHALL BE CHECKED BY THE VENDOR
1.3	CASTING	1.SURFACE CONDITION	MA	VISUAL	100%		FREE FROM CRACKS, BLOW HOLES ETC.	LOG BOOK	3	-	2	
		2.CHEM. & PHY. PROP.	MA	CHEM & MECH TEST	1/HEAT NO.	MANFR'S DRG./SPEC	RELEVENT IS/	SUPPLIER'S TC	3	-	2	HEAT NO. SHALL BE VERIFIED
		3.DIMENSIONS	MA	MEASUREMENT	100%	MANUFR'S DRG.	MANUFR'S DRG.	LOG BOOK	3	-	2	
1.4	PAINT & VARNISH	1.MAKE, SHADE, SHELF LIFE & TYPE	MA	VISUAL	100% CONTINUOUS	MANFR'S DRG./SPEC	MANFR'S DRG./SPEC	LOG BOOK	3	-	2	

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ : VENDOR			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 2 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.5	SHAFT (FORGED OR ROLLED)	1. SURFACE COND.	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	-	VENDOR'S APPROVAL IDENTIFICATION SHALL BE MAINTAINED
		2. CHEM. & PHYSICAL PROPERTIES	MA	CHEM. & PHYSICAL TESTS	1/HEAT NO. OR HEAT TREATMENT BATCH NO	MFG. DRG. SPEC.	RELEVANT IS	SUPPLIER'S TC	3	-	2	
		3. DIMENSIONS	MA	MEASUREMENT	100%	-DO-	MANUFR'S DRG.	LOG BOOK	3	-	2	
		4.INTERNAL FLAWS	CR	UT	-DO-	ASTM-A388	MANUFR'S SPEC. BHEL SPEC.	-DO-	3	2	1	FOR DIA OF 55 MM & ABOVE
1.6	SPACE HEATERS, CONNEC-TORS, TERMINAL BLOCKS, CABLES, CABLE LUGS, CARBON BRUSH TEMP. DETECTORS, RTD, BTD'S	1. MAKE & RATING	MA	VISUAL	-DO-	MANUFR'S DRG. SPEC.	MANUFR'S DRG. SPEC.	-DO-	3	-	2	
		2. PHYSICAL COND.	MA	-DO-	-DO-	-	NO PHYS. DAMAGE, NO ELECTRICAL DISCONTINUITY	-DO-	3	-	2	
		3.DIMENSIONS (WHEREVER APPLICABLE)	MA	MEASUREMENT	SAMPLE	MANUFR'S DRG./ SPEC.	MANUFR'S DRG. / SPEC.	-DO-	3	-	2	
		4.PERFORMANCE/ CALIBRATION	MA	TEST	100%	-DO-	-DO-	INSP. REPORT	3	-	2	

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
	NAME		
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	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 3 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	W	V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.7	OTHER INSULATING MATERIALS LIKE SLEEVES, BINDINGS CORDS, PAPERS, PRESS BOARDS ETC.	1. SURFACE COND. ETC.	MA	VISUAL	100%	-	NO VISUAL DEFECTS	INSPT. REPORT	3	-	2	
		2. OTHER CHARACTERISTICS	MA	TEST	SAMPLE	MANUF'S SPEC.	MANUF'S SPEC.	LOG BOOK AND OR SUPPLIER'S TC	3	-	2	
1.8	SHEET STAMPING (PUNCHED)	1. SURFACE COND.	MA	VISUAL	100%	-	NO VISUAL DEFECTS (FREE FROM BURS)	LOG BOOK	3	-	-	
		2.DIMENSIONS INCLUDING BURS HEIGHT	MA	MEASUREMENT	SAMPLE	MANUFR'S DRG. .	MANUFR'S DRG.	-DO-	3	-	2	FOR MV MOTOR INSULA-TION/VARNISH THICKNESS SHALL BE MORE THAN THE BURS HEIGHT
		3. ACCEPTANCE TESTS	MA	ELECT. & MECH TESTS	-DO-	MANUF'S SPEC./ RELEVANT IS	RELEVANT IS	SUPPLIER'S TC	3	-	2	
1.9	CONDUCTORS	1. SURFACE FINISH	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	LOG BOOK	3*	-	2*	* MOTOR MANUFACTURER TO CONDUCT VISUAL CHECK FOR SURFACE FINISH ON RANDOM BASIS (10% SAMPLE) AT HIS WORKS AND MAINTAIN RECORD FOR VERIFICATION BY BHEL/CUSTOMER.
		2.ELECT. PROP, & MECH. PROP	MA	ELECT. & MECH.TEST	SAMPLES	RELEVANT IS/ BS OR OTHER STANDARDS	RELEVANT IS/ BS OR OTHER STANDARDS	SUPPLIERS TC & VENDOR'S INSPN. REPORTS	3	-	2	

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
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	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 4 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
		3.DIMENSIONS	MA	MEASUREMENT	-DO-	-DO-	-DO-	Log Book	3	-	2	
1.10	BEARINGS	1.MAKE & TYPE	MA	VISUAL	100%	MANFR'S DRG./ APPROVED DATASHEET	MANFR'S DRG./ APPROVED DATASHEET	-DO-	3	-	2	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	BHEL DATA SHEET	BHEL DATA SHEET BEARING MANUF'S CATALOGUES	-DO-	3	-	2	
		3.SURFACE FINISH	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	2	
1.11	SLIP RING (WHEREVER APPLICABLE)	1.SURFACE COND.	MA	VISUAL	100%	-	-DO-	-DO-	3	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANUF'S DRG	MANUF'S DRG	-DO-	3	-	-	
		3.TEMP.WITH-STAND CAPACITY	MA	ELECT.TEST	-DO-	MANUF'S SPEC./ BHEL SPEC.	MANUF'S SPEC./ BHEL SPEC.	-DO-	3	-	2	
		4.HV/IR	MA	-DO-	100%	-DO-	-DO-	-DO-	3	-	2	
1.12	OIL SEALS & GASKETS	1.MATERIAL OF GASKET	MA	VISUAL	100%	MANUF'S DRG/SPECS	MANUF'S DRG./ SPECS.	-DO-	3	-	-	
		2.SURFACE COND.	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	-	
		3.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANUF'S DRG	MANUF'S DRG	-DO-	3	-	-	

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
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	QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ : VENDOR			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 5 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
2.0	IN PROCESS											
2.1	STATOR FRAME WELDING (IN CASE OF FABRICATED STATOR)	1.WORKMANSHIP & CLEANNESS	MA	VISUAL	100%	-DO-	GOOD FINISH	LOG BOOK	3/2	2	-	
		2.DIMENSIONS	MA	MEASUREMENT	-DO-	MANUF'S DRG	MANUF'S DRG	-DO-	2	-	-	
2.2	MACHINING	1.FINISH	MA	VISUAL	100%	-DO-	GOOD FINISH	LOG BOOK	2	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	-DO-	MANUF'S DRG	MANUF'S DRG	-DO-	2	-	-	
		3.SHAFT SURFACE FLOWS	MA	PT	-DO-	RELEVENT SPEC./ ASTM-E165	MANUFR'S SPEC./ BHEL SPEC./	-DO-	2	-	1	
2.3	PAINTING	1.SURFACE PREPARATION	MA	VISUAL	100%	MANFR'S SPEC/BHEL SPEC./ RELEVANT STAND	BHEL SPEC. SAME AS COL.7	LOG BOOK	2	-	-	
		2.PAINT THICKNESS (BOTH PRIMER & FINISH COAT)	MA	MEASUREMENT BY ELCOMETER	SAMPLE	-DO-	-DO-	-DO-	2	-	-	
		3.SHADE	MA	VISUAL	-DO-	-DO-	-DO-	Log Book	2	-	-	
		4.ADHESION	MA	CROSS CUTTING & TAPE TEST	-DO-	-DO-	-DO-	Log Book	2	-	-	

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ : VENDOR			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 6 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**			**11**
2.4	SHEET STACKING	1.COMPLETENESS	MA	MEASUREMENT	SAMPLE	MANUFR'S SPEC.	MANUFR'S SPEC.	Log Book	2	-	-	
		2.COMPRESSION & TIGHTENING	MA	MEASUREMENT	100%	-DO-	-DO-	Log Book	2	-	-	
		3.CORE LOSS & HOTSPOT	MA	ELECT.TEST	-DO-	-DO-	-DO-	Log Book	2	1*	1	(FOR MOTORS OF 2MW AND ABOVE) * ON 10% RANDOM SAMPLE
2.5	WINDING	1.COMPLETENESS	CR	VISUAL	100%	MANUFR'S SPEC./BHEL SPEC.	MANUFR'S SPEC./BHEL SPEC.	Log Book	2	-	-	
		2.CLEANLINESS	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-	
		3.IR-HV-IR	CR	ELECT. TEST	-DO-	-DO-	-DO-	Log Book	2	-	1	
		4.RESISTANCE	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	
		5.INTERTURN INSULATION	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-	
		6.SURGE WITH STAND AND TAN. DELTA TEST	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	FOR MV MOTOR
2.6	IMPREGNATION	1.VISCOSCITY	MA	PHY. TEST	AT STARTING	-DO-	-DO-	Log Book	2	-	-	
		2.TEMP. PRESSURE VACCUM	MA	PROCESS CHECK	CONTINUOUS	-DO-	-DO-	Log Book	2	-	-	
		3.NO. OF DIPS	MA	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	THREE DIPS TO BE GIVEN

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN	CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
		BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 7 OF 9	SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	W	V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
		4.DURATION	MA	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	
2.7	COMPLETE STATOR ASSEMBLY	1.COMPACTNESS & CLEANLINESS	MA	VISUAL	100%	-DO-	-DO-	Log Book	2	-	-	
2.8	BRAZING/COMPRESSION JOINT	1.COMPLETENESS	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-	
		2.SOUNDNESS	CR	MALLET TEST & UT	-DO-	-DO-	-DO-	Log Book	2		1	
		3.HV	MA	ELECT. TEST	-DO-	-DO-	-DO-	Log Book	2		1	
2.9	COMPLETE ROTOR ASSEMBLY	1.RESIDUAL UNBALANCE	CR	DYN. BALANCE	-DO-	MFG SPEC./ ISO 1940	MFG. DWG.	Log Book	2		1	VERIFICATION FOR MV MOTOR ONLY
		2.SOUNDNESS OF DIE CASTING	CR	ELECT. (GROWLER TEST)	-DO-	MFG. SPEC.	MFG. SPEC.	Log Book	2		1	
2.10	ASSEMBLY	1.ALIGNMENT	MA	MEAS.	-DO-	-DO-	-DO-	Log Book	2	-	-	
		2.WORKMANSHIP	MA	VISUAL	-DO-	-DO-	-DO-	Log Book	2	-	-	
		3.AXIAL PLAY	MA	MEAS.	-DO-	-DO-	-DO-	Log Book	2	-	1	
		4.DIMENSIONS	MA	-DO-	-DO-	MFG.DRG./ MFG SPEC.	MFG. DRG/ RELEVANT IS	Log Book	2	-	-	
		5.CORRECTNESS, COMPLETENESS TERMINATIONS/ MARKING/ COLOUR CODE	MA	VISUAL	100%	MFG SPEC. RELEVANT IS	MFG SPEC. RELEVANT IS	Log Book	2	-	-	
		6. RTD, BTD & SPACE HEATER MOUNTING.	MA	VISUAL	100%	MFG SPEC. RELEVANT IS	MFG SPEC. RELEVANT IS	Log Book	2		1	

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN	CUSTOMER :	PROJECT TITLE	SPECIFICATION : NUMBER :
		BIDDER/ VENDOR :	QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03	SPECIFICATION : TITLE
	SHEET 8 OF 9	SYSTEM	ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)	SECTION VOLUME III

SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
3.0	TESTS	1.TYPE TESTS INCLUDING SPECIAL TESTS AS PER BHEL SPEC.	MA	ELECT.TEST	1/TYPE/SIZE	IS-325/ BHEL SPEC./ DATA SHEET	IS-325/ BHEL SPEC./ DATA SHEET	TEST REPORT	2	1*	1	* NOTE - 1
		2.ROUTINE TESTS INCLUDING SPECIAL TEST AS PER BHEL SPEC.	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1$	1	$ NOTE - 2
		3.VIBRATION & NOISE LEVEL	MA	-DO-	100%	IS-12075 & IS-12065	IS-12075 & IS-12065	-DO-	2	1$	1	$ NOTE - 2
		4.OVERALL DIMENSIONS AND ORIENTATION	MA	MEASUREMENT & VISUAL	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET & RELEVANT IS	INSPC. REPORT	2	1	-	
		5.DEGREE OF PROTECTION	MA	ELECT. & MECH. TEST	1/TYPE/ SIZE	RELEVANT IS	BHEL SPEC. AND DATA SHEET	TC	2	-	1	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		6. MEASUREMENT OF RESISTANCE OF RTD & BTD	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1$	1	$ NOTE - 2
		7. MEASUREMENT OF RESISTANCE, IR OF SPACE HEATER	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1$	1	$ NOTE - 2
		8. NAMEPLATE DETAILS	MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPC. REPORT	2	1$	1	$ NOTE - 2
		9.EXPLOSION FLAME PROOF NESS (IF SPECIFIED)	MA	EXPLOSION FLAME PROOF TEST	1/TYPE	IS-3682 IS-8239 IS-8240	IS-3682 IS-8239 IS-8240	TC	2	-	1	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		10. PAINT SHADE, THICKNESS & FINISH	MA	VISUAL & MEASUREMENT BY ELKOMETER	SAMPLE	BHEL SPEC. & DATA SHEET	BHEL SPEC. & DATA SHEET	TC	2	1$	1	SAMPLING PLAN TO BE DECIDED BY INSPECTION AGENCY $ NOTE - 2

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :		
			BIDDER/ : VENDOR			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE		
	SHEET 9 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION		VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11

NOTES:

1 DEPENDING UPON THE SIZE AND CRITICALLY, WITNESSING BY BHEL SHALL BE DECIDED.

2 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON.

3 IN CASE TEST CERTIFICATES FOR THESE TESTS ON SIMILAR TYPE, SIZE AND DESIGN OF MOTOR FROM INDEPENDENT LABORATORY ARE AVAILABLE, THESE TEST MAY NOT BE REPEATED.

4 WHEREVER CUSTOMER IS INVOLVED IN INSPECTION, AGENCY (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER.

Legends for Inspection agency

1. BHEL/CUSTOMER
2. VENDOR (MOTOR MANUFACTURER)
3. SUB-VENDOR (RAW MATERIAL/COMPONENTS SUPPLIER)

P. PERFORM
W. WITNESS
V. VERIFY

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

		QUALITY PLAN	CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-006, REV-01			SPECIFICATION TITLE			
		SHEET 1 OF 2	SYSTEM			ITEM AC ELECT. MOTORS BELOW 55KW (LV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.0	ASSEMBLY	1.WORKMANSHIP	MA	VISUAL	100%	MANUF'S SPEC	MANUF'S SPEC	-DO-	2	-	-	
		2.DIMENSIONS	MA	-DO-	-DO-	MFG. DRG./ MFG. SPEC.	MFG. DRG./ MFG. SPEC.	-DO-	2	-	-	
		3.CORRECTNESS COMPLETENESS TERMINATIONS/ MARKING/COLOUR CODE	MA	VISUAL	100%	MFG.SPEC./ RELEVANT IS	MFG.SPEC. RELEVANT IS	-DO-	2	-	-	
2.0	PAINTING	1.SHADE	MA	VISUAL	SAMPLE	MANUFR'S SPEC/BHEL SPEC./RELEVANT STANDARD	BHEL SPEC. SAME AS COL.7	LOG BOOK	2	-	-	
3.0	TESTS	1.ROUTINE TEST INCLUDING SPECIAL TEST AS PER BHEL SPEC.	MA	-DO-	100%	IS-325/ BHEL SPEC./ DATA SHEET	SAME AS COL.7	TEST REPORT	2	1		NOTE -1 & NOTE-3
		2.OVERALL DIMENSIONS & ORIENTATION	MA	MEASUREMENT & VISUAL	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET & RELEVANT IS	INSPN. REPORT	2	1	-	NOTE -1 & NOTE-3
BHEL			**PARTICULARS**		**BIDDER/VENDOR**							
			NAME									
			SIGNATURE									

	QUALITY PLAN	CUSTOMER :		PROJECT TITLE			SPECIFICATION : NUMBER :			
		BIDDER/ VENDOR :		QUALITY PLAN NUMBER PED-506-00-Q-006, REV-01			SPECIFICATION : TITLE :			
	SHEET 2 OF 2	SYSTEM		ITEM AC ELECT. MOTORS BELOW 55KW (LV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	W	V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
		3.NAMEPLATE DETAILS	MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPN. REPORT	2	1	-	

NOTES:

1 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON

2 WHERE EVER CUSTOMER IS INVOLVED IN INSPECTION, (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER.

3 FOR EXHAUST/VENTILATION FAN MOTORS OF RATING UPTO 1.5KW , ONLY ROUTINE TEST CERTIFICATES SHALL BE FURNISHED FOR SCRUTINY.

Legends for Inspection agency

1. BHEL/CUSTOMER
2. VENDOR (MOTOR MANUFACTURER)
3. SUB-VENDOR (RAW MATERIAL/COMPONENTS SUPPLIER)

P. PERFORM
W. WITNESS
V. VERIFY

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

CABLE SCHEDULE FORMAT

ANNEXURE III

UNITCABLENO	FROM	TO	PURPOSE	CABLE SCOPE (BHEL PEM/ VENDOR)	REMARKS	CABLESIZE	PATHCABLENO	TENTATIVE CABLE LENGTH

Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in PEM.

1. For the purpose of clarity, it may please be noted that the information given in regard to the cables to be routed through WinPath as per the system elaborated below is called "Cable List", while the term "Cable Schedule" applies to the cable list with routing information added after routing has been carried out.

2. The cable list shall be entered as an MS Excel file in the format as per enclosed template EXT_CAB_SCH_FORMAT.XLS. No blank lines, special characters, header, footer, lines, etc. shall be introduced in the file. No changes shall be made in the title line (first line) of the template.

3. The field properties shall be as under:
    a. UNITCABLENO: A/N, up to sixteen (16) characters; each cable shall have its own unique, unduplicated cable number. In case this rule is violated, the cable cannot be taken up for routing.
    b. FROM: A/N, up to sixty (60) characters; the "From" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
    c. TO: A/N, up to sixty (60) characters; the "To" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
    d. PURPOSE: A/N, up to sixty (60) characters; the purpose (i.e. power cable/ indication/ measurement, etc.) to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
    e. REMARKS: A/N, up to forty (40) characters; Any information pertinent to routing to be specified here (e.g., cable number of the cable redundant to the cable number being entered). Information in excess of 40 characters will be truncated after 40 characters.
    f. CABLESIZE: A/N, 7 characters exactly as per the codes indicated below shall be specified here. The program cannot route cables described in any other way/ format.
    g. PATHCABLENO: Field reserved for utilization by the program. User shall not enter any information here.

4. One list shall be prepared for each system/ equipment (i.e., separate and unique cable lists shall be prepared for each system).

5. The cables shall be described as per the scheme listed below:

Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in PEM.

A	NN	A	NNN
|	|	|	|
Cable Voltage Code (see B below)	No. of cores (e.g. 01,03,3H, 07)	Cable code (See C below)	Cable size (e.g. 035,185,2.5, 0.5)

please refer below examples:

i) 3C x 120 sq. mm. (1.1kV) PVC FRLS, Unarmoured Aluminium cable, the voltage code shall be D03G120
ii) 3C x 2.5 sq. mm. (1.1kV) PVC FRLS, Unarmoured Copper cable, the voltage code shall be D03C2.5
iii) 3.5C x 120 sq. mm. (1.1kV) PVC non-FRLS, Armoured Aluminium cable, the voltage code shall be D3HF120

(A) SYSTEM VOLTAGE CODES:

(ac) A = 11KV, B = 6.6KV, C = 3.3KV, D = 415V, E = 240V, F = 110V
(dc) G = 220V, H = 110V, J = 48V, K = +24V, L = -24V

(B) CABLE VOLTAGE CODES:

A = 11KV (Power cables)
B = 6.6KV (Power cables)
C = 3.3KV (Power cables)
D = 1.1KV (LV & DC system power & control cables)
E = 0.6KV (0.5 sq. mm. Control cables)

(C) CABLE CODES

PVC Copper

A = Armoured FRLS	B = Armoured Non-FRLS
C = unarmoured FRLS	D = Unarmoured Non-FRLS

Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in PEM.

PVC Aluminium

E = Armoured FRLS	F = Armoured Non-FRLS
G = unarmoured FRLS	H = Unarmoured Non-FRLS

XLPE Copper

J = Armoured FRLS	K = Armoured Non-FRLS
L = unarmoured FRLS	M = Unarmoured Non-FRLS

XLPE Aluminium

N = Armoured FRLS	P = Armoured Non-FRLS
Q = unarmoured FRLS	R = Unarmoured Non-FRLS

S = FIRE SURVIVAL CABLES
T = TOUGH RUBBER SHEATH
U = OVERALL SCREENED
V = PAIRED OVERALL SCREENED
W = PAIRED INDIVIDUAL SCREENED
Y = COMPENSATING CABLES
I = PRE-FABRICATED CABLES
Z = JELLY FILLED CABLES

6. Once a cable list has been given to PEM for routing, any subsequent changes required in the cable list (which may be in the form of addition of cables, deletion of cables, change of type or size of cable, etc.) must be informed as specific changes (as a separate file MS Excel of the same format as the original file) to the cable list given earlier if the cable list has been routed and cable schedule generated. The routing status of the cable list shall be got confirmed from PEM by the agency that has prepared the cable list before the changes are intimated. In case PEM confirms that the cable list in question has not been taken up for routing, and the revised cable list is acceptable,

the same may be sent. Since cable routing through the program involves adding each cable list to the project cable schedule database, the original cable schedule shall not be furnished to PEM with revisions incorporated within.

7. For any assistance or clarifications, please contact mailto:praveendutta@bhelpem.co.in

SECTION-C3
(SPECIFIC TECHNICAL REQUIRMENT-C&I)

C&I TECHNICAL SPECIFICATION
FOR DCS BASED
PRE-TREATMENT PLANT

	PATRATU STP STATION EXPANSION PHASE–I (3X 800MW)		DESG	JKG	
	JOB NO: 434		CHKD	MK	
	REV. NO. 00	DATE: 20.12.2018	APPD	BS	

INDEX

S. No.	DESCRIPTION
1	TITLE SHEET
2	INDEX SHEET
3	SPECIFIC TECHNICAL REQUIREMENTS (C&I)
4	SPECIFICATION FOR MEASURING INSTRUMENTS (PRIMARY & SECONDARY)
5	LIST OF DOCUMENTS/DELIVERABLES
6	DATA SHEETS FOR MOTORISED VALVE ACTUATOR
7	SIGNAL EXCHANGE BETWEEN DRIVES & DCS (DCP)
8	INSTRUEMNT STUB DETAILS
9	QUALITY ASSURANCE FOR INSTRUMENTS
11	SUB VENDOR LIST
12	INSTRUMENT INSTALLATION DRAWING
13	CABLE INTERCONNECTION AND TERMINATION PHILOSOPHY
14	MANDATORY SPARES
15	KKS TAGGING PHILOSOPHY

SPECIFIC TECHNICAL REQUIREMENTS (C&I)

SPECIFIC TECHNICAL REQUIREMENTS (C&I) WITH SCOPE OF SUPPLY:

1) Pre-Treatment Plant shall be operated from DCS (BHEL Scope) through operator work stations located in the respective control room.

2) The Contractor shall provide complete Instrumentation for control, monitoring and operation of entire Pre-Treatment Plant. The requirements given are to be read in conjunction with detailed Technical specification enclosed in the specification. Further in case of any discrepancy in the requirement within the same or different section, as noted by the bidder in the specification, the same will be brought to the notice of BHEL in the form of pre- bid clarification. In absence of any pre-bid clarification, the more stringent requirement as per interpretation of BHEL/customer shall prevail without any commercial implication.

3) The make/model of various instruments/items/systems shall be as per attached vendor list. No commercial and delivery implication in this regard shall be acceptable. In case of any conflict and repetition of clauses in the specification, the more stringent requirements among them are to be complied with.

4) Number of pairs to be selected for Screen /Control cable
   a. F-Type: 2P/4P/8P/12P (Size: 0.5mm2) for Analog signals.
   b. G-Type: 2P/4P/8P/12P (Size: 0.5mm2) for Binary signals.
   c. Core Cable: 3CX2.5mm2, 5CX2.5mm2,
   (also shown in Drive control philosophy sheets).

5) For cable supply scope refer electrical scope between BHEL and vendor defined in Electrical Specification.

6) The quantity of instruments for the system in tender P &ID wherever provided of the respective system is minimum, for bidding purpose. However, Bidder shall also include in his proposal all the instruments and devices that are needed for the completeness of the plant auxiliary system/ equipment supplied by the bidder, even if the same is not specifically appearing in the P & ID. During detail engineering if any additional instruments are required for safe & reliable operation of plant, bidder shall supply the same without any price implication.

7) The specifications for instruments mentioned in the specification are minimum requirements. The detail specifications shall be finalized during detail engineering.

8) Bidder to terminate all instrumentation and control elements in junction boxes/LCP. Number of Junction Boxes shall be sufficient and positioned in the field to minimize local cabling (max 12-15 mtrs) and trunk cable.

9) Bidder to provide documents Instrument Schedule, I/O list, Drive list, Cable Schedule, Cable interconnection, JB grouping, Annunciation list, recommended control logics / write-up ,SOE list, List of Instruments/devices for HART in BHEL approved format as per List Of Deliverables Sheet enclosed. Also reusable database format like MS Excel, MS Access etc. of these documents shall also be provided by Contractor in BHEL approved format. Soft copy of the formats shall be provided to the successful bidder.

10) All the transmitters supplied by Bidder shall be rack & enclosure mounted. The transmitter racks shall be in Bidder's scope of supply (Please refer the detailed specification sheet under clause 5.00.00, Local Instrument Enclosure & Racks). All transmitters shall be HART compatible.

11) Bidder to perform tests of C&I items/instruments/systems as per Quality plans/type test attached in the specification. However, if any test not specified in the quality plan but specified in specification Tests for I&C equipment included elsewhere in specification will have to perform by Bidder without any cost implication.

12) Instrument installation and accessories required for the same shall be in Bidder's scope and shall be submitted after award of contract. However any instrument/Analyser installation not covered in the same shall be subject to customer and BHEL approval during detailed engineering. The necessary root valves, impulse piping, drain cocks, gauge-zeroing cocks and all the other accessories required for mounting/ erection of these local instruments shall be provided by bidder, even if not specifically asked for, on as required basis. The contacts of equipment mounted instruments; sensors etc. for external connection including spare contacts shall be wired out to suitably located junction boxes by bidder.

13) Double root valve shall be provided for all pressure tapings where the pressure exceeds 40kg/cm2.

14) Typical Hook-up diagram is included for reference.

15) 415 V/230 V AC Power supply shall be provided by BHEL at a single point, further distribution to various instruments/equipment of the system shall be in bidder scope. Bidder to include necessary power distribution board, changeover circuit in his scope. Any power supply other than the above, if required by any instrument/equipment has to be derived by the bidder from the above supply & all necessary hardware for the same shall be in bidder scope. Bidder to submit the power requirement along with the bid.

16) Electrical Actuators with integral starter shall be provided for all on/off and inching type valves along with necessary interface units for linking to corresponding Control System as applicable,

17) All field instruments enclosure shall be IP65 local panel/cabinet enclosure shall be IP 55, unless specified otherwise.

18) For level transmitters, electronics items etc. all weather canopy\ rack enclosures shall be provided for protection from direct sunlight and rain for open locations. For applications where transmitter location is not accessible, the transmitter shall have separate sensor unit and electronic unit for such applications. It shall be possible to mount the electronic unit at accessible location.

19) Interface of MCC, field Equipment, Actuators etc. with DDCMIS based control system shall be as per Drive Control Philosophy enclosed in specification.

20) Redundancy of sensors shall be provided by bidder
    (i) Triple redundancy for all analog and binary inputs required for protection of the system/drives.
    (ii) For all other control functions dual redundancy of the sensors shall be provided by the bidder.

21) The PDBs (in bidders scope) provided for distribution of UPS loads shall be as per following guidelines. Each PDB shall be provided with input feeder monitoring through potential free contact wired to DCS.The output feeders from the PDB shall be provided with separate fuse & MCB's. 10% spare feeders (min. 1 no.) with MCB & fuses for each rating shall be provided in Bidder's each PDB.

22) The solenoid operated valves/Dampers/Gate shall have a limit switch for open/close feedback.Solenoid Valve shall be rated for 24V DC only.

23) Diaphragm seal shall be provided with Instruments having contact with corrosive media.

24) The bidders shall specifically mention any deviation they would like to take on the C&I specification. In absence of only deviation, a No deviation certificate is to be furnished.

25) Bidder to perform tests of C&I items/instruments/systems as per Quality plans/type test attached in the specification. However, if any test not specified in the quality plan but specified in specification Tests for I&C equipment included elsewhere in specification will have to perform by Bidder without any cost implication.
26) All Temperature sensors shall be Duplex type and temperature transmitter shall be provided for all temperature measurement applications.
27) Bidder to provide compensating cable if required, JB/Rack & other erection hardware.

28) Use of process actuated shall be avoided unless unavoidable.

29) Bidder to furnish electrical load/UPS load data during detailed engineering.

30) Interface of MCC/SWGR, field instruments, Actuators etc. with DDCMIS based control system shall be as per Drive Control Philosophy enclosed in specification.

31) Local control panel if any required for operation shall be in bidder scope.

32) Universal Hand Held Calibrator is not in bidder's scope.However, all the transmitters (as applicable) supplied by bidder should have provision for calibration by Universal Hand Held Calibrator.

33) Bidder’s presence is required for 3 Man days (Excluding travel time) at EDN Bangalore during FAT of DDCMIS for certifying correctness & completeness of implementation of Control logic. Intimation to attained FAT shall be informed in 2 days advance. All the expenses like boarding, lodging and travel, Air fare etc. shall be in bidder’s scope.

34) Contractor's C&I representative shall be present at BHEL-PEM for 3 man-days, for preparation of Control schemes etc. All the expenses like boarding, lodging and travel, Air fare etc. shall be in bidder’s scope.

35) Bidder’s presence is required for 15 Man days (in three visit) at site during commissioning of DDCMIS for assistance related to process correctness. Three visit with total 15 Man days (Excluding travel time) in which one visit shall be of 5 Man days each. All the expenses like boarding, lodging and travel, Air fare etc. shall be in bidder’s scope.

36) At least 20% spare unused terminals shall be provided everywhere including local junction boxes, instrument racks/enclosures, termination/marshalling cabinets, etc.

37) Measuring instruments (primary & secondary), analysers (if applicable) offered for this package shall have at least one year's satisfactory operation in one power station having unit rating of 200 MW or above. Provenness certificate shall be provided as per the attached format.

GENERAL REQUIREMENT

1.0 Bidder shall provide complete and independent control & instrumentation system with all accessories, auxiliaries and associated equipments for the safe, efficient and reliable operation of auxiliary systems.

2.0 Measuring instruments/equipment and subsystems offered by the bidder shall be from reputed experienced manufacturers of specified type and range of equipment, whose guaranteed and trouble free operation has been proven. Further all the instruments shall be of proven reliability, accuracy, and acceptable international standards and shall be subject to employer's approval. All instrumentation equipment and accessories under this specification shall be furnished as per technical specification, ranges, makes/ numbers as approved by the employer' during detail engineering.

Annexure - 4
FORMAT FOR PROVENNESS CERTIFICATE

Sl.No.	Item Description	Plant No.1
5.00.00	**INSTRUMENTS (PRIMARY & SECONDARY)**	
	(i) Type of Instrument	
	(ii) Make / Model	
	(iii) Name of Power Station (Location & Address)	
	(iv) Unit Size (MW)	
	(v) Commissioning date	
	Whether above instruments have atleast one (1) year satisfactory operation in one (1) power station having unit rating of 200 MW or above.	Yes/No
	(vi) Client's certificate attached	Yes/No

Signature of authorized signatory.....

SPECIFICATION FOR MEASURING INSTRUMENTS (PRIMARY & SECONDARY)

1.00.00	**MEASURING INSTRUMENTS (PRIMARY AND SECONDARY)**
1.01.00	Measuring instruments/equipment and subsystems offered by the Bidder shall be from reputed experienced manufacturers of specified type and range of equipment, whose guaranteed and trouble free operation has been proven. Refer Sub-section Basic Design Criteria. Further, all instruments shall be of proven reliability, accuracy, and repeatability requiring a minimum of maintenance and shall comply with the acceptable international standards and shall be subject to Employer's approval.
1.02.00	Every panel-mounted instrument requiring power supply shall be provided with easily replaceable glass cartridge fuses of suitable rating. Every instrument shall be provided with a grounding terminal and shall be suitably connected to the panel grounding bus.
1.03.00	All transmitters, sensors, switches and gauges for parameters like pressure, temperature, level, flow etc. as required for the safe and efficient operation and maintenance as well as for operator and management information (including all computation) of equipment in the system under the scope of specification shall be provided on as required basis with in quoted lump sum price. The Contractor shall furnish all Instrumentation / Control equipment & accessories under this specification as per technical specification, ranges, makes & model as approved by the Employer during detailed engineering.
1.04.00	The necessary root valves, impulse piping, drain cocks, gauge-zeroing cocks, valve manifolds and all the other accessories required for mounting/erection of these local instruments shall be furnished, even if not specifically asked for, on as required basis. The contacts of equipment mounted instruments, sensors, switches etc. for external connection including spare contacts shall be wired out in flexible/rigid conduits, independently to suitably located common junction boxes. The proposal shall include the necessary cables, flexible conduits, junction boxes and accessories for the above purpose. Double root valves shall be provided for all pressure tapping where the pressure exceeds 40 Kg./sq.cm.
	For Chlorine application: Instruments shall be provided with wetted parts (e.g. diaphragm seal, etc.) made of Hastelloy C. Also, filled liquid shall be Fluorolube oil/ Inert Hydrocarbon / CTFE etc., for these applications. For applications of FECL3 solution: Instruments shall be provided with wetted parts (e.g. diaphragm seal, etc.) made of Tantalum.

2.00.00 **SPECIFICATION FOR ELECTRONIC TRANSMITTERS**

2.01.00 **SPECIFICATION FOR ELECTRONIC TRANSMITTER FOR PRESSURE, DIFF PRESS AND DP BASED FLOW / LEVEL MEASUREMENTS**

Sl.No.	Features	Essential/Minimum Requirements
1.	Type of Transmitter	Microprocessor based 2 wire type (loop powered), Hart protocol compatible.
2.	Accuracy	± 0.1% of calibrated span (minimum)
3.	Output signal range	4-20 mA DC (Analog) along with superimposed digital signal (based on HART protocol)
4.	Turn down ratio (minimum)	10:1 for vacuum/very low pressure applications (i.e. pressure <= 200 mmWC) 5:1 for very high pressure application (i.e. pressure >= 200 Kg/cm2) 30:1 for other applications
5.	Stability	± 0.1% of calibrated span for six months for Ranges up to and including70 Kg/cm² ± 0.25% of calibrated span for six months for Ranges more than 70 Kg/cm²
6.	Zero and span drift	+/- 0.015% per deg.C at max span +/-0.11% per deg.C at min. Span
7.	Load impedance	500 ohm (minimum)
8.	Housing	Weather proof as per IP-65, metallic housing with durable corrosion resistant coating
9.	Over Pressure	150% of max. Operating pressure
10.	Connection (Electrical)	Plug and socket type
11.	Process connection	1/2 inch NPT (F)
12.	Span and Zero	Continuous, tamper proof, Remote as well as manual adjustability from instrument with zero suppression and elevation facility.
13.	Accessories	-Diaphragm seal, pulsation dampeners, syphon etc. as required by service and operating condition. -2 valve manifold for absolute & Gauge pressure transmitters, 3-valve and 5 valve manifold for DP/Level/Flow applications. The valve manifold shall be non integral type (except Fuel Oil area).

		-For hazardous area, explosions proof enclosure as described in NEC article 500 Mounting: 2 inch pipe mounting.
14.	Diagnostics & display	Self-Indicating feature and digital display on transmitter
15.	Power supply	24V DC ± 10%.

Notes

- For primary air/ secondary air/flue gas applications, DP type transmitters shall be provided for pressure measurement.
- LVDT type is not acceptable.
- Where the process fluids are corrosive, viscous, solid bearing or slurry type, diaphragm seals shall be provided. Parts below the diaphragm shall be removable for cleaning. The entire volume above the diaphragm shall be completely filled with an inert liquid suitable for the application.

2.02.00 GUIDED WAVE RADAR TYPE LEVEL TRANSMITTER

Type	Microprocessor based 2 wire type (loop powered), HART protocol compatible Guided wave radar transmitter.
Principle	TDR (Time domain reflectometry)
Probe Type & Material	(i) Coaxial probe of SS316/316L. If required, probe shall be suitable for overfill prevention. (ii) Rod probe, cable probe of SS316/SS316L can be used for applications wherever coaxial probe is not suitable.
Output signal	4-20 mA DC along with superimposed digital signal (based on HART protocol), suitable for over fill prevention.
Accuracy	+/- 0.5% of calibrated span or minimum 5mm.
Power supply	24 VDC +/- 10%.
Housing	Weather proof as per IP-65, metallic housing with durable corrosion resistance coating.

Adjustment/ calibration	Using hand held HART calibrator/ centralized PC based system (as applicable).
Zero & span adjustment	Continuous, temper proof, remote as well as manual adjustability from instrument. It should be possible to calibrate the instrument without any level in the tank/sump etc.
Display	Integral digital display.
Load Impedance	500 ohms (minimum).
Electromagnetic compatibility	Shall meet EN 61326-1 (1997) and AmdtA1, class A equipment/EN 50081-2 & EN 5008 1-2 & EN 50082-2
Mounting	(i) External cage shall be provided where ever side mounting is required. External cage and other mounting accessories to be provided by the contractor. (ii) Where ever top mounting is required, all mounting accessories, stilling well (as required) etc., shall be provided by the contractor. (iii) All weather canopy shall be provided for protection from direct sunlight and direct rain for open locations.

Note: Four wire type transmitters can also be provided for applications where 2- wire transmitter has some technical limitations, subject to employer's approval during detailed engineering stage. However, in such cases isolated 4-20 mA DC (analog) output shall be provided. Power supply required for such transmitters shall be 240V AC / 24V DC.

2.03.00 Ultrasonic Type level Transmitter

S.No.	Features	Essential/Minimum requirement
1.	Type of Transmitter	Non-contact Microprocessor based 2 wire type (loop powered), HART protocol compatible Ultrasonic transmitter.
2.	Output signal	4-20 mA DC (Analog) along with superimposed digital signal (based on HART protocol).

3.	Accuracy	+/- 0.5% of calibrated span or minimum 5mm.
4.	Power supply	24 V DC +/- 10%.
5.	Temperature compensation	To be provided within transducer.
6.	Housing	Weather proof as per IP-65, metallic housing with durable corrosion resistance coating.
7.	Adjustment/calibration/ maintenance	Using hand held HART calibrator/ centralized PC based system (as applicable). .
8.	Zero and Span adjustment	Continuous, tamper proof, remote as well as manual adjustability from instrument. It should be possible to calibrate the instrument without any level in the tank/sump etc.
9.	Sensor Material	Corrosion resistant material to suit individual application requirement.
10.	False signal tolerance	Transmitter shall be capable of ignoring false echoes from internal tank/sumps obstructions such as pipes, heating coils or agitator blades. Also transmitter shall have adjustable damping circuitry.
11.	Range	Range of transmitter shall be capable of covering the complete level span of tank taking care of blocking distance, frequency attenuation due to surface, obstructions, vapors etc.
12.	Display	Integral digital display
13.	Diagnostics	Loss of echo alarm etc.
14.	Load Impedance	500 ohms (minimum).
15.	Electrical Connection	Plug and socket

16.	Accessories	• All weather canopy shall be provided for protection from direct sunlight and direct rain for open locations. • All mounting accessories required for erection and commissioning shall be provided. • For hazardous area, explosion proof enclosure as described in NEC article 500

Note:

1) Contractor can also provide Radar type transmitter as per above specification in place of ultrasonic transmitter subject to approval by Employer during detailed Engineering. Sonic frequency based transmitters can also be provided under “ultrasonic transmitters” category for fly ash silo level.

2) Four wire type transmitters can also be provided for applications where 2- wire transmitter has some technical limitations, subject to employer’s approval during detailed engineering stage. However, in such cases isolated 4-20 mA DC (analog) output shall be provided. Power supply required for such transmitters shall be 240V AC / 24V DC.

3) For applications where transmitter location is not accessible, the transmitter shall have separate sensor unit and electronic unit for such applications. It shall be possible to mount the electronic unit at accessible location.

3.00.00 **Temperature Elements and accessories**

3.01.00 **Thermocouple**

Sr. No.	Features		Essential/Minimum Requirements
1	Type of Thermocouple.	:	16 AWG wire of Chromel-Alumel (Type K) or 24 AWG wire Pt-Rhodium Pt (Type R) depending on operating temperature Range (ungrounded separate junction type).
2	No. of element	:	Duplex
3	Housing/Head	:	IP-65/Diecast Aluminium. Head of TE to be provided with sufficient space and arrangement to mount head mounted temperature transmitter (as applicable). Plug in connectors are to be provided for external signal cable connection. TE terminal head shall be spring loaded for positive contacts with the thermo well.
4	Insulation and Sheathing of Thermocouple	:	Swaged type mineral (magnesium oxide) insulation and SS316 sheath.
5	Calibration and accuracy	:	As per IEC-584/ ANSI-MC-96.1 (special limits of errors/ class1) for T/C.
6	Accessories	:	Thermo well and associated fittings
7	Standard	:	IEC-584/ ANSI MC 96.1 for Thermocouple and ASME PTC-19.3 for Thermo-well

3.02.00 **Resistance Temperature Detector (RTD)**

Sr. No.	Features		Essential/Minimum Requirements
1	Type of RTD.	:	Four wire, Pt-100 (100 Ohms resistance at zero degree Centigrade).
2	No. of element	:	Duplex
3	Housing/Head	:	IP-65/Diecast Aluminium. Head of TE to be provided with sufficient space and arrangement to mount head mounted temperature transmitter (as applicable). Plug in connectors are to be

				provided for external signal cable connection. TE terminal head shall be spring loaded for positive contacts with the thermo well
	4	Insulation and sheathing of RTD	:	Mineral (magnesium oxide) insulation and SS316 sheath,
	5	Calibration and accuracy	:	As per As per IEC-751/ DIN-43760 Class-A for RTD
	6	Accessories	:	Thermo well and associated fittings
	7	Standard	:	IEC-751/ DIN-43760 for RTD and ASME PTC-19.3 for Thermo-well.

NOTES :

1) The specifications for RTDs of winding/ bearings of motor/pump, can be as per their manufacturer standards. The manufacturer shall submit the adequate supporting documents for establishing their standard practice. However the type of RTD shall be Pt100.

2) The specifications of temp elements for air conditioning & ventilation system / process can be as per system manufacturer's standards. The manufacturer shall submit the adequate supporting documents for establishing their standard practice.

3.03.00 Metal Temperature Thermocouples

Measuring Medium	Metal Temperature
Material of Thermocouple.	Chromel Alumel Type K
Type of Thermocouple	Duplex with ungrounded separate hot junctions
Insulation	Mineral Insulation (Magnesium Oxide).
Thermocouple wire gauge	16 AWG
Protective sheath	SS 321
Protective sheath dia	8 mm OD
Calibration & accuracy	As per IEC-584/ ANSI-MC-96.1 (special limits of error) for T/C
Mounting accessories	1/2" BSP SS sliding end connector, weld pad, clamps of heat resistant steel SS310. Adjustable gland fitting for connection at the junction box end as per manufacturer's standard.
Cold end sealing	SS pot seal with colour coded PTFE Insulated flexible tails. Sealing compound- Epoxy resin. Length of PTFE insulated flying leads shall be minimum 750 mm.

	Minimum bending radius	30 mm
	Length of T/C	On as required basis considering location of measurement point and the JB/TTJB location.

Notes :

1) The specification for thermocouples of bearings metal temp measurements can be as per their manufacturer standards. The manufacturer shall submit the adequate supporting documents for establishing their standard practice. However type of thermocouples shall be K-type.

2) For boiler metal temperature applications, considering the location of installations and response time, manufacturer's standard and proven specification for metal temperature measurement can also be accepted subject to employer's approval. The manufacturer shall submit adequate supporting documents for establishing their standard and proven practice.

3.04.00 **Thermo well** (for all process temp. elements)

(a) Shall be one piece solid bored type of 316 SS of step-less tapered design. (As per ASME PTC 19.3, 1974)

3.05.00 **Not Used**

3.06.0 **TEMPERATURE TRANSMITTER (TT)**

Following types of 2-wire (loop powered) temperature transmitter (directly powered from 4-20mA input cards of DDCMIS/PLC) shall be provided. The temperature transmitter shall be fully compatible with thermocouples and RTDs being provided by the contractor. Temperature compensation of the thermocouples shall be performed in the temperature transmitter itself.

a. Single Input Head mounted Temperature Transmitter

These shall be suitable for mounting in the head of temperature element itself. Temperature transmitter and associated temperature element shall be factory fitted.

b. Single Input DIN-rail mounted Temperature Transmitter

These shall be suitable for mounting on DIN-rails in JBs. The specifications of the JBs shall be same as indicated in Subsection INST CABLE with additional DIN-rails and IP 65 Protection class. This temperature transmitter shall be the ones which are

especially designed for DIN-rail mounting with IP 20 protection class. These shall have terminals for input/output provided on front side when mounted on DIN-rail. Head mounted temperature transmitter with clamps to make it suitable for DIN-rail mounting shall not be acceptable under this category.

c. Dual-input Temperature Transmitter With **integral** Indicator:

These shall be suitable for mounting on pipes/ support. Both elements of the duplex thermocouple/ RTD shall be wired to a single transmitter. Integral indicator shall be provided with these transmitters. These transmitters shall have bump less change over facility to second sensor in case first sensor fails .This change-over is to be alarmed. Protection class shall be IP65 minimum.

d. Common requirements for each of the above type of temperature transmitters.

Output	:		2-wire (power supply from input card of Control System) with 4-20mA output with superimposed HART protocol signal.
Input	:		Same transmitter shall be capable to handle Pt-100 RTD, Thermocouples –K & R types (input type to be selectable at site through HART terminal).
Isolation	:		Min. 500 V AC.
EMC compatibility	:		As per EN 61326.
Operating ambient temperature	:		0 to 85 deg C (without indicator). 0 to 70 deg C (with indicator).
Power supply			24V DC +/- 10%.
Accessories			Mounting arrangements including clamps etc.
Composite Accuracy	(i)		For head mounted and DIN-rail mounted types:
(Refer note 2)		RTD	=<0.4% of 0-250 deg C span
		T/C-K type	=<0.4% of 0-600 deg C span
		T/C-R type	=<0.4% of 0-1000 deg C span
		CJC accuracy (for thermocouples) shall be =< 1 deg C	
	(ii)		For dual-input type:
		RTD	=<0.25% of 0-250 deg C span
		T/C-K type	=<0.2% of 0-600 deg C span
		CJC accuracy (for thermocouples) shall be =< 1 deg C	

e. Field bus compatible temperature transmitters

Temperature transmitters of this category shall be field mounting type & shall be capable of withstanding operating ambient temperature upto 85 deg C. These modules shall be connected to DDCMIS through field bus such as Profibus, Foundation Field bus etc directly from the transmitter. Maximum Number of inputs per such temperature transmitter shall be eight. These shall be mounted in cabinets/enclosures/JBs in non-AC areas.

As an alternate, these signals from temperature transmitters can be connected to DDCMIS through standard remote I/O modules of the DCS, in which case, the temperature transmitter signals will be acquired through 4-20mA input modules in the remote I/O cabinet for connecting to DDCMIS through remote I/O bus.

Air conditioned panel shall be provided for remote I/O.

Notes ***(Common for a) to d) above):-***

1. In case of failure (open or burn-out) of RTD/thermocouple, temp. Transmitter shall provide low temperature output.
2. Composite Accuracy is to be calculated as summation of all applicable accuracies of temp transmitter, for converting sensor input to output in 4-20 mA (e.g., basic accuracy, digital accuracy, D/A accuracy, etc.) and temperature effect on these accuracies at ambient temperature of 50 deg C, based on the figure/ formula given in the standard product catalogue for span as specified above for various types of Temperature Elements specified. All such accuracy/ temp effect figures in catalogue shall be first converted to deg C, and then percentage of this converted accuracy in specified span shall be calculated to compare with the specified composite accuracy figures. All temperature transmitters are to be interchangeable (i.e. can be used for either RTD or thermocouple) and composite accuracy shall be met for each type of input specified in (i) & (ii).

8.00.00 **E-P Converter**

E-P converters and associated accessories shall be furnished in accordance with the specifications given below :

A. Fail Freeze Type E/P convertes

1	Air supply Pressure	:	2 kg/sq. cm.
2	Input signal	:	4-20mA DC
3	Output signal	:	0.2 to 1.0 kg/sq. cm
4	Linearity	:	0.5% of span or better.
5	Span/Zero Adjustment	:	To be provided
6	Hysteresis	:	0.5% of span or better.
7	Fail Freeze Feature	:	Stay put at last position on failure of 4 –20mA signal.
8	Allowable drift rate	:	Maximum 2% set point/ hour.
9	Ambient Temperature Effect	:	less than 0.02% of span per deg C between -
10	Mounting	:	Surface/Pipe/Bracket Mounting.
11	Protection class	:	IP 65.
12	Connection Port Sizes	:	¼ inch NPT (F)
13	Electrical Cable Entry	:	½ inch NPT
14	Output Pressure Gauge	:	1/4 inch NPT connection, 2 inch dial.
15	Accessories	:	All accessories like mounting brackets, fittings etc. required for installation is to be supplied.

B. FaiL Safe type E/P converters

1	Air supply Pressure	:	2 kg/sq. cm.
2	Input signal	:	4-20mA DC
3	Output signal	:	0.2 to 1.0 kg/sq. cm
4	Linearity	:	0.5% of span or better.
5	Span/Zero Adjustment	:	To be provided.
6	Hysteresis	:	0.5% of span or better.
7	Fail Safe Feature	:	Output shall drive to minimum on failure of either 4-20mA signal or air supply.
8	Mounting	:	Surface/Pipe/Bracket Mounting.
9	Ambient Temperature Effect	:	less than 0.02% of span per deg C between -20 to +60 deg C.
10	Protection class	:	IP 65.
11	Connection Port Sizes	:	¼ inch NPT (F)
12	Electrical Cable Entry	:	½ inch NPT
13	Output Pressure Gauge	:	1/4 inch NPT connection, 2 inch dial.
14	Accessories	:	All accessories like mounting brackets, fittings etc. required for installation is to be supplied.

12.00.00	**SPECIFICATION FOR CORIOLIS FLOW TRANSMITTER**	
	Type	Coriolis
	Material of Wetted Parts	316 SS
	Material of Housing	304L SS
	Accuracy	± 0.2% of Rate
	Repeatability	± 0.1% of Rate
	Output	4-20 mA DC, HART Compatible

	Power Supply	230 VAC or 24VDC operated
	Process Temperature range	0-200 degree Celsius
	Others	Drain / purging arrangement shall be provided as per standard practice.
	Viscosity range of Fluid	0-500cst for HFO

The offered Coriolis type flow transmitter shall be suitable for intended application. Contractor shall submit flow and sizing calculation for Employer's approval. For each type of Coriolis type flow transmitter general arrangement and assembly drawing and cable wiring diagram shall be submitted for Employer's approval.

13.00.00 SPECIFICATION FOR FLOW ELEMENTS

13.01.00 Orifice Plate

Features	Essential/Minimum Requirements
Type	Concentric as per ASME PTC-19.5 (Part-II), ISA RP-3.2, 1960 or BS-1042, ISO 5167
Material	316 SS
Thickness	3 mm for main pipe diameter up to 300 mm and6 mm for main pipe dia above300 mm.
Material of branch pipe	Same as main pipe
Root valve type	Globe
Root valve material	Same as pipe material
Root valve size	1 / 2 inch or 1 inch (as applicable)
Impulse pipe of same material up to root valve	Required
Tappings	Flanged weld neck or D & D/2 with 3 pairs of tapping (as applicable). Root valves to be provided in all the tappings.
Beta Ratio	0.34 to 0.7
Beta Ratio calculation to be submitted	Yes
Assembly drg. and flow Vs DP Curves	Yes
Accessories	Root valves, flanges, Vent/drain hole(As required)

Contractor shall submit certified flow calculation and differential pressure vs. flow curves for each element for Employer's approval. Sizing calculation, precise flow calculation for all the flow elements, fabrication and assembly drawings and installation drawings shall be submitted for Employer's approval.

13.02.00 Flow Nozzle

Features	Essential/Minimum Requirements
Type	Long radius, welded type as per ASME PTC-19.5 (Part-III) or BS-1042
Material	316 SS
Thickness	Suitable for intended application.
Material of branch pipe	Same as main pipe
Root valve type	Globe
Root valve material	Same as pipe material
Root valve size	1 inch
Impulse pipe of same material up to root valve	Required
Tapping	Flanged weld neck or D & D/2 with 3 pairs of tapping (as applicable). Root valves to be provided in all the tappings.
Beta Ratio	Around 0.7
Beta Ratio calculation to be submitted	Yes
Assembly drg. and flow Vs DP Curves	Yes
Accessories	Root valves, vent and drain hole.

Contractor shall submit certified flow calculation and differential pressure vs. flow curves for each element for Employer's approval. Sizing calculation, precise flow calculation for all the flow elements, fabrication and assembly drawings and installation drawings shall be submitted for Employer's approval.

13.03.00 **Venturi (For Liquid applications)**

Features	**Essential/Minimum Requirements**
Type	Rough Welded (for Pipe dia between 200mm to 1200mm) or Machined (for Pipe dia 50mm to 250mm) as per ISO 5167-4:2003,
Material	Same as Main Pipe
Thickness	Same as Main Pipe.
Root valve type	Globe Type
Root valve material	Same as Pipe material

	Root valve size	1 inch
	Impulse pipe of same material up to root valve	Required
	Tapping	3 Nos. of tappings for each Venturi as per ISO 5167-4:2003
	Beta Ratio	0.4 to 0.7
	Beta Ratio calculation to be Submitted	Yes
	Assembly drg. and flow Vs DP Curves	Yes
	Accessories	Root valves, vent and drain hole.

Contractor shall submit certified flow calculation and differential pressure vs. Flow curves for each element for employer's approval. Sizing calculation, precise flow calculation for all the flow elements, fabrication and assembly drawings and installation drawings shall be submitted for employer's approval.

13.04.00 **ROTAMETERS**

Sr. No.	Features	Essential / minimum requirements
1.	Type	Variable Area Metal Tube
2.	Fluid media	Water/oil
3.	Tube body	SS316
4.	Material of float	316 SS
5.	Indicator	Linear scale
6.	Accessories	Flange, orifice in case of bypass Rota meter (for line size above 100 mm)
7.	Housing protection class	IP-55
8.	Accuracy	± 2% of measured value.

14.00.00 POSITIVE DISPLACEMENT TYPE FLOW TRANSMITTERS

The Bidder shall provide positive displacement type flow transmitters for fuel oil flow measurement, suitable for the fuel oil being used for the project, i.e., keeping in view the pressure, temperature and viscosity of the fuel oil.

The meter shall be a volumetric meter type consisting of two meshing oval wheels driven by the fluid. Each revolution of the oval wheels shall displace a precisely known volume of the fluid from inlet to outlet. The housing/measuring chamber and oval wheels shall be of 316 SS.

The measurement accuracy of the transmitter shall be better than +0.2%.

The transmitter shall provide suitable 4-20mA dc output signal for control and indication/recording. Converters if necessary shall be provided to generate the 4-20mA signal.

A local indicator of fuel oil flow shall also be provided. The instrument shall be calibrated in Tons/hr.

Suitable strainer shall be provided before the transmitter for the protection of oval wheel meters against foreign matter contained in the fuel oil.

The exact model no. and type of material being used, etc., shall be subject to Employer's approval during detailed engineering without any price repercussion to Employer.

15.00.00 PROCESS ACTUATED SWITCHES

FEATURES	ESSENTIAL / MINIMUM REQUIREMENTS		
	Pressure/ Draft Switches/ DP Switches	Temperature switches	Level switches
Sensing Element	Piston actuated for high pressure and diaphragm or bellows for low pr./ vacuum	Vapor pressure sensing, liquid filled bellow type with SS bulb and capillary (5 m minimum, to suit application)	Capacitance types, float type, conductivity type, RF type, Ultrasonic type as per suitability to the application. .
Material	316 SS	Bulb 316 SS/ capillary 304 SS	316 SS
End connection	½ inch NPT (F)	½ inch NPT (F)	Manufacturer standard
Over range/ proof pressure	150% of maximum operating pr.	-	150% of maximum operating pr.
Repeatability	+/- 0.5% of full range		
No. of contacts	2 No.+2NC. SPDT snap action dry contact		
Rating of contacts	60 V DC, 6 VA (or more if required by DDCMIS)		
Elect. Connection	Plug in socket.		
Set point adjustment	Provided over full range.		
Dead band adjustment	Adjustable/ fixed as per requirement of application.		

Enclosure	Weather and dust proof as per IP-55, metallic housing.		
Accessories	Siphon, snubber, chemical seal, pulsation dampeners as required by process	Thermo well of 316 SS and packing glands	All mounting accessories
Mounting	Suitable for enclosure/ rack mounting or direct mounting	Suitable for rack mounting or direct mounting	-
Power Supply (wherever required)	As per Contractor's Standard practice.		

Notes :-

1) Where the process fluids are corrosive, viscous, solid bearing or slurry type, diaphragm seals shall be provided. Parts below the diaphragm shall be removable for cleaning. The entire volume above the diaphragm shall be completely filled with an inert liquid suitable for the application.

2) Pressure/ Diff pressure switches for very low press/ DP measurements can have sensor material other than SS316 in case of any technical limitation and the offered product is standard product of the manufacture for very low pressure applications.

3) Repeatability can be upto +/-1% of full range in case of switches with diaphragm seals or very low pressure/DP range.

4) The specifications of switches for air conditioning & ventilation system / process can be as per system manufacturer's standards. The manufacturer shall submit the adequate supporting documents for establishing their standard practice.

16.00.00 **NOT USED**

17.00.00 **SOLENOID VALVES**

Solenoid valves shall fulfil the following requirements:

a. Type 2/3/4 way SS 316/Forged Brass (depending on the application subject to Employer's approval during detailed Engg.)

b. Power supply : 24 V DC ± 10%.

c. Plug and socket electrical connection.

d. Insulation : Class 'H'

18.00.00 **REVERSE ROTATION INDICATOR (RRI)**

Reverse rotation indicator comprising of proximity sensors, processing electronics with output of 4-20mA (corresponding to speed) interconnecting cables, speed display in rpm,

normal, reverse indication and required channel alarm contact shall be provided. The contact rating shall be 60VDC, 6VA (or more if required by Control system). The exact details of the RRI shall be strictly as approved by Employer during detailed engineering. The power supply of RRI is to be arranged by the Bidder

19.00.00 WATER SYSTEM RELATED SPECIAL INSTRUMENTS (DM PLANT, CPU PLANT, PT PLANT, ETC)

19.01.00 ANALYSER INSTRUMENTS:

For Technical specification of Cation/Specific Conductivity, pH, Sodium, Silica, Turbidity, Total Dissolved Solids (TDS) and Concentration analysers, please refer Specification of Analysers, Part-B, Sub-section IIIC-13, SWAS chapter of this specification.

19.02.00 Residual Chlorine Analyser

a An automatic chlorine residual analyser of amperometric type shall be provided alongwith the chlorinating plant for monitoring the residual chlorine content of cooling water. The analyser shall be suitable for accurate residual measurement in open/closed systems. The measurement accuracy shall not be affected by presence of treatment chemicals as chromates, phosphates, de-former highly polluted water, change in temperature etc.

b The analyser shall comply with the following specification requirements, as a minimum

(i)	Indicator	:	Provision of LC display in the panel of analyser.
(ii)	Range	:	0 to 20.0 mg/L (ppm)
(iii)	Accuracy	:	2% or better
(iv)	Sensitivity	:	0.01 mg/1
(v)	Output signal	:	4-20mA DC isolated output,
(vi)	Alarm annunciation	:	High and low alarms to be provided on panel and shall be field adjustable.
(vii)	Calibration	:	Zero and span adjustment facility to be provided. Final calibration adjustments of the analyser to be done at site and duly verified by titration. Temperature compensation range 0 to 50degC.
(x)	Mounting	:	The analyser shall be suitable for field mounting conform to protection class IP-55.
(xii)	Electrodes	:	Platinum/Gold and copper electrodes shall be provided with cell cleaning system.

(c) Circulating water as sample to residual chlorine analyser shall be taken from hot circulating water pipe work before entry to cooling towers. Exact location and layout of sampling arrangement shall be finalised during detailed engg. stage. Bidder shall provide necessary pumping system (with 100% standby) for meeting the analyser requirements, if needed. All the drains shall be terminated up to the nearest plant drainage system.

19.03.00 All the outdoor field instruments such as analysers/transmitters/meters etc. shall be provided with suitable Free standing cabinet(s)/panel/rack so that the equipments are protected against rain/ sunlight etc.

19.04.00 **Parshall Flume**

The Bidder shall provide all the control and Instrument devices including primary sensors, transmitters, flow indicator cum integrator / totaliser and shall include all required accessories for the flow measurement of raw water through the clarifier. The system shall be of reputed make and acceptable to the owner.

Level measurement shall be based on ultrasonic/radon technology. The flow compensation is to be implemented in the transmitter itself. The transmitter shall provide 4-20 mA DC in direct proportion to flow and shall be able to drive a load impedance of 500 ohms minimum

Accuracy shall be +/- 1 % or better.

All the mounting hardware and accessories required for erection and commissioning of the same are to be provided by the contractor. Mounting fittings material shall be SS316. All weather canopy is to be provided for electronics/sensor to protect the same from rain/ sunlight etc.

The Type makes and models no. shall be subject to Owner's approval.

19.05.00 **Electronic Flow-Meter**

The electronic flow meter shall include flow sensor and flow indicator cum integrator / totaliser and shall include all required accessories for satisfactory operation. The flow meter shall be based on full bore electromagnetic principle and shall be electronic type of proven design, make and model acceptable to the owner.

The Bidder shall submit all necessary technical literature and details of selection criteria of the instrument offered to substantiate the model selected. The Bidder shall also furnish list of similar installation along with feed back on satisfactory performance of the instruments.

The flow meter shall meet or exceed the following requirement :

(a)	Output	:	4-20 mA DC Isolated output
(b)	Accuracy	:	± 0.5% of calibrated span or better *
(c)	Repeatability	:	± 0.2% of calibrated span or better
(d)	Power Supply	:	240V AC ± 10%, 50 HZ ± 5%/ 24 V DC, to be arranged by the contractor.
(f)	Protection class	:	IP-55
(e)	Flow tube		SS304
(f)	liner		Hard Rubber

The flow meter shall provide local indication for instantaneous flow. It should also be possible to get local display for daily and monthly discharge. The flow meter shall indicate totaliser/ integrator to get the daily and monthly discharge as stated above.

21.00.00 **Limit switches**

For offsite plant application Limit switches shall be gold plated with high conductivity and non corrosive type. Contact rating shall be sufficient to meet the requirement of DDCMIS subject to a minimum of 60 V, 6 VA rating. Protection class shall be IP 55.

For main plant application limit switches are to be provided as per contractor standard and proven practice.

22.01.00 **COMMON REQUIREMENTS FOR ALL ANALYSERS**

Sno	Features	Minimum Requirement
1.	Output signals	Analog 4-20 mA DC galvanically isolated.
2.	Zero & span Adjustment	To be provided with range selection facility
3.	Ambient temp	50 degC
4.	Sample Temperature	40 degC
5.	Indication	Digital Alphanumeric Display of reading in engineering units shall be provided.

6.	Type of Electronics	Microprocessor based with self-diagnostic
7.	Calibration	Manual
8.	Others	All interconnection tubing and cabling between sensor and analyzer / analyzer panel etc to be provided. All chemical reagents required for EQMS analyzers for entire AMC period is to be supplied in phased manner depending on shelf life.
9.	Location of the Temp & flow measurement	Effluent Treatment plant outlet (Exact location to be decided by contractor in consultation with site)
10.	Location of the Analyser cabinet/enclosure	
11.	Accessories	All the accessories required for mounting the sensor/analyser are to be provided
12.	Digital Signal Transmission	Each analyser shall have a provision for bidirectional soft connectivity over Modbus/RS232/RS485 with employer's central cloud server in addition to 4-20 ma connectivity to DDCMIS.
13.	Compliance to standards	CPCB's (Central Pollution control Board) latest regulatory requirement prevailing at the time of execution of the contract.

22.02.00 CONDUCTIVITY ANALYSER

Type	Continuous flow through type
Measuring Range	0 – 60000 µS/cm for sea water application 0-5000 µS/cm for other application
Response Time	<= 5 sec (90% of full scale)
Temperature Compensation	Automatic
Power	To be arranged by the contractor
Accuracy	<= +/- 1 %

22.03.00 pH ANALYSER

Type	Cell flow through sample
Measuring Range	0-14 units of pH
Temperature Compensation	Automatic
Power	To be arranged by the contractor.
Accuracy	<= +/- 1 %

22.04.00 BOD BIOLOGICAL OXYGEN DEMAND / COD CHEMICAL OXYGEN DEMAND ANALYSER

Principle	COD/BOD measurement by: Option A. Total Organic Carbon (TOC) measurement complying to US EPA 415.1 / 415.2 or equivalent standard for effluent/sewage/waste water. Option B. UV-VIS spectrometer measuring absorption in UV-VIS spectrum.
Measuring Range	0-50 mg/L for BOD, 0-500 mg/L for COD
Response Time	<= 15 min
Power	To be arranged by contractor
Cleaning	Self-cleaning (Automatic)
Accuracy	+/- 3%

22.05.00 OIL IN WATER ANALYSER

Principle	UV Fluorescence
Measuring Range	0 to 30 mg/l
Response Time	<= 60 sec
Power	To be arranged by the contractor.
Cleaning	Self-cleaning (Automatic)
Accuracy	+/- 5 % of full scale

22.06.00 TOTAL SUSPENDED SOLIDS – TSS ANALYSER

Principle	Light reflection principle
Measuring Range	0-500 mg/l
Response Time	<= 5 min
Power	To be arranged by bidder (Refer terminal point)
Cleaning	Self-cleaning (Automatic)
Accuracy	+/- 5%

22.07.00 **ENCLOSURE/CABINETS / PANELS**

The enclosure shall accommodate all EQMS Analyser. The enclosure shall provide protection from dust, humidity, precipitations, sunlight and environmental pollution. The material for the enclosure shall be of steel plate with minimum 2 mm thick frame and 1.6 mm thick CRCA steel sheet of protection IP 55 or better with safety lock of good quality. The lighting provision in the cabinet and the canopy for the cabinet is to be provided. The cabinets shall be designed such that the wet section and dry section are separate, the exact details shall be finalized during detailed engineering.

In order to ensure the healthy operation of the installed electronic modules, cards, analyzers, etc inside the enclosure during continuous operation, the EQMS enclosure shall be provided with Air conditioner unit .

SPECIFICATIONS FOR PR. GAUGE, D.P. GAUGE, TEMP. GAUGE AND LEVEL GAUGE.

Sl. No	FEATURES	ESSENTIAL/MINIMUM REQUIREMENTS		
		Pr. Gauge/ DP Gauge/ Draught gauges	Temperature Gauge	Level Gauge
1	Sensing Element and material	Bourdon for high pressure, Diaphragm/Bellow for low pr. Of 316 SS	Mercury in steel for below 450°C and inert gas actuated for above 450°C of SS bulb and capillary.	Tempered * toughened Borosilicate gauge glass steel armoured reflex or transparent type.
2	Body material	Die-cast aluminium	Die-cast aluminium	Forged carbon steel/304 SS
3	Dial size	150mm	150 mm	Tubular covering entire range
4	End connection	1/2 inch NPT (M)	3/4" NPT (M)	Process connection as per ASME PTC and drain/vent 15 NB
5	Accuracy	±1% of span	± 1% of span	± 2%
6	Scale	Linear, 270° arc graduated in metric units	Linear, 270° arc graduated in °C	Linear vertical
7	Range selection	Cover 125% of max. of scale	Cover 125% of max. of scale	Cover 125% of max. of scale
8	Over range test	Test pr. for the assembly shall be1.5 to the max. Design pr. at 38°C.		
9	Housing	Weather and dust proof as per IP-55	Weather and dust proof as per IP-55	CS/304 SS leak proof
10	Zero/span adjustment	Provided	Provided	--
11	Identification	Engraved with service legend or laminated phenolic name plate		

12	Accessories	Blow out disc, siphon, snubber, pulsation dampener, chemical seal (if required by process) gauge isolation valve	SS Thermowell	Gasket for all KEL-F shield for transparent type vent and drain valves of Steel/SS as per CS/Alloy process Requirement.
13	Material of Bourdon/ movement	316 SS / 304 SS	316 SS / 304 SS	

Notes:-

*Bicolour type level gauges will be provided for applications involving steam and water except for condensate and feed water services.

Length of gauge glass shall not be more than 1400 mm. If the vessel is higher, multiple gauge glasses with 50 mm overlapping shall be provided.

Where the process fluids are corrosive, viscous, solid bearing or slurry type, diaphragm seals shall be provided. Parts below the diaphragm shall be removable for cleaning. The entire volume above the diaphragm shall be completely filled with an inert liquid suitable for the application.

9.04.00 The Bidder shall be responsible for proper grounding of all equipment under this package. Further, proper termination of cable shields shall be verified and the grounding of the same shall be coordinated so as to achieve grounding of all instrumentation cable shields at same potential. This shall be completed prior to system tests.

9.05.00 The Contractor shall take full care while laying / installing cables as recommended by cable manufacturers regarding pulling tensions and cable bends. Cables damaged in any way during installation shall be replaced at the expense of the Contractor.

10.00.00 FIELD MOUNTED LOCAL JUNCTION BOXES

(i)	No. of ways	12/24/36/48/64/72/96/128 with 20% spares terminals.
(ii)	Material and Thickness	4mm thick Fiberglass Reinforced Polyester (FRP).
(iii)	Type	Screwed at all four corners for door. Door gasket shall be of synthetic rubber.
(iv)	Mounting clamps and accessories	Suitable for mounting on walls, columns, structures etc. The brackets, bolts, nuts, screws, glands required for erection shall be of SS, included in Bidders scope of supply.
(v)	Type of terminal blocks	Rail mounted cage-clamp type suitable for conductor size upto 2.5 mm^2. A M6 earthing stud shall be provided.
(vi)	Protection Class	IP: 55 minimum for indoor & IP-65 minimum for outdoor applications.
(vii)	Grounding	To be provided.
(viii)	Color	RAL 7035

11.00.00 CONDUITS

11.01.00 Conduits shall be generally used for interconnecting cables from field instruments to Local JB's. All rigid conduits, couplings and elbows shall be hot dipped galvanised rigid mild steel in accordance with IS: 9537 Part-I (1980) and Part-II (1981). The conduit interior and exterior surfaces shall have continuous zinc coating with an overcoat of transparent enamel lacker or zinc chromate. Flexible conduit shall be heat resistant lead coated galvanized steel with , water leak, fire and rust proof protected *for the areas of* Mills,Drum, Main Steam, RH steam Air Heaters and Furnace, BFPDT's .

And for remaining applications, water leak, fire and rust proof flexible GI conduits shall be provided. The temperature rating of flexible conduit shall be suitable for actual application.

11.02.00 All rigid conduit fittings shall conform to the requirements of IS: 2667, 1976. Galvanized steel fitting shall be used with steel conduit. All flexible conduit fittings shall be liquid tight, galvanized steel. The end fittings shall be compatible with the flexible conduit supplied.

11.03.00 Conduit sealing, explosion proof, dust proof and other types of special fittings shall be provided as required by these specifications and shall be consistent with the area and equipment with which they are installed. Fittings installed outdoors and in damp locations shall be sealed and gasketed. Hazardous area fittings and conduits sealing shall conform

3.00.00 **SPECIFICATION OF ANALYSERS**

3.01.00 Field proven reputed international make microprocessor based monitors/analyzers with LCD display and with necessary fault diagnostic features shall be employed. All analysers shall provide 4-20mA output signal capable of driving a load impedance of 500Ohms minimum. The type, size, capacity, material, make, model and other specification details of the rest of the SWAS system like coolers, gauges/switches, sample pipes, filter, pressure reducing elements, grab sampling arrangement, valves & fittings, panels etc. shall be as decided during detailed engineering stage and shall be subject to Employer's approval. The power supply to all the analysers/ monitors shall be supplied by Contractor from his UPS system with all necessary switches, fuses, wiring/cabling and other required accessories etc. for distribution to individual requirements.

Minimum specifications of analysers					
Requirements	**Conductivity**	**PH**	**Phosphate**	**Chloride**	**Turbidity**
Type	For Hotwell, Two removable Type of Cells, For Others, Continuous Flow Through Type	Cell Flow Through sample	Colorimetric	Continuous Flow Through Type with Chloride & Sulphate Responsive Electrodes	Light reflection principle
Accuracy	≤ ± 1%	≤ ± 1%	≤ ± 5% of reading	≤ ± 5%	≤ 2% for range 0-50 NTU, ≤ 5% for range 50 – 200 NTU

Response Time (90 % of Full Scale)	≤ 5 sec.		≤ 16 min.		≤ 5 min.
Range	0-1, 0-10, 0-100 micro-mho/cm (freely programmable) for Specific Conductivity. 0-1 micro-mho/cm log scale for Cation conductivity	6-11 pH freely programmable	0-10 ppm freely programmable	0-1000 ppb freely programmable	0 – 100, 0-200 MTU, programmable
Temperature Compensation	Automatic/	Automatic	Automatic	Automatic	
Sample Flow			50-150 ml/min		
No. of Streams	Single	Single	Single	Single	

Minimum specifications of analysers …….continued

Requirements	**Hydrazine**	**Silica**	**Sodium**	**Dissolved O2**	**Total Iron (Fe)**
Type	Automatic Continuous Electrochemical Type	Continuous Colorimetric Type	Continuous Flow Through sample	Continuous Flow Through sample	Continuous Flow Through sample
Accuracy	≤ ± 5%	≤ ± 5% of reading	≤ ± 10% of reading	≤ ± 5% of reading	<±5 % of reading or ±0.005 ppm
Response Time (90 % of Full Scale)	≤ 3 min.	≤ 15 min. (including sample switching)	≤ 4 min.	≤ 30 sec.	≤ 15 min. (including sample switching)
Stability	Calibration Once in a Month		Calibration Once in a Month		

Range	0-50, 0-100 ppb freely programmable	0-50, 0-100 ,0-500 ppb freely programmable	0-1,0-10, 0-200 ppb freely programm-able	0-20,0-200 ppb freely programmable	0-50ppb, 0-150ppb, 0-300ppb, 0-1ppm, 0-5ppm freely programm-able or as per the process requirement.
No. of Streams	Single	Multi stream with sequencer/ stream selector (min. 4 streams)	Multi stream with sequencer/ stream selector (min. 4 streams)	Single	Multi stream with sequencer/ stream selector (min. 4streams)
Temperature Compensation	Automatic	Automatic	Automatic	Automatic	Automatic
Sample Flow	170 ml/min (max)	50-150 ml/min	125 ml/min (max)	170 ml/min (max)	200ml/min (max)
REMARKS	All the analysers/cells shall have open Corrosion resistant drain to waste header.				
	Analysers/ monitors/ cells shall be suitable for operating under the conditions specified.				
	Dual cation exchange column shall be provided for cation conductivity.				
	For Hot well conductivity measurement, the Contractor shall provide direct insertion / withdrawal type conductivity cell whereas for all other samples it shall be flow-through type. Monitors for hot well conductivity shall be suitable for field mounting.				

4.00.00 **SAMPLE PIPING SYSTEM**

4.01.00 This shall include piping, fittings, valves and accessories from tapping point upto SWAS conditioning panel located in SWAS room on as required basis. All sample piping shall be 3/4" NB seamless type of material ASTM A213 TP 316 H, conforming to ANSI B36.19. The schedule number shall be suitable for the particular application.

4.02.00 All fittings shall be socket welding type and of material ASTMA182 F316H conforming to ANSI B 16.11.

4.03.00 Single and multi tubes shall run with the minimum number of changes in direction. Suitable identification tags shall be provided for easy check up and for proper connections.

4.04.00 The valves to be used in sample piping shall be of stainless steel conforming to ASTM A182. The pressure temperature ratings shall be as per ANSI B16.34. The valve design shall be such that the seats can be reconditioned and stem and disc can be replaced without

LIST OF DOCUMENTS/DELIVERABLES

PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE–I (3X 800MW)			
DOCUMENT NUMBER PE-GL-434-145-I100 SHEET 1 of 1			
Sl.No.	DRAWING NO.	DRAWING/DOCUMENT TITLE	CATEGORY
1	PE-V2-434-145-I902	HMI PICTURES/PLANT SCHEMATICS	A
2	PE-V2-434-145-I903	INSTRUMENT SCHEDULE with set points	A
3	PE-V2-434-145-I904	Input/ output (I/O) LIST (ANALOG & BINARY)	A
4	PE-V2-434-145-I905	DRIVE LIST/SOLENOID/ACTUATOR VALVE LIST WITH LOCATION DATA	A
5	PE-V2-434-145-I906	FIELD JB/LIE/LIR TERMINATIONS DETAILS	A
6	PE-V2-434-145-I907	DATASHEETS FOR INSTRUMENTS, JBs, etc.	A
7	PE-V2-434-145-I908	QUALITY PLANS (for INSTRUMENTS etc.)	A
8	PE-V2-434-145-I909	CABLE SCHEDULE & INTERCONNECTION	A
9	PE-V2-434-145-I910	Instrument installation drawings and the drawings for open racks & closed racks (as applicable)	A
10	PE-V2-434-145-I911	THERMOWELL SIZING CALCULATION for applicable services as per ASME PTC 19.3 (latest revision)	A
11	PE-V2-434-145-I912	CONTROL SCHEME/LOGIC DIAGRAM (TO BE IMPLEMENTED IN DDCMIS)	A
12	PE-V2-434-145-I913	ANNUNCIATION & SOE LIST	A
13	PE-V2-434-145-I914	CONTROL & OPERATIONAL WRITE-UP FOR THE SYSTEM	A
14	PE-V2-434-145-I915	ANNUNCIATION & SOE LIST	A

NOTES: 1. ANY OTHER DOCUMENT DECIDED DURING DETAILED ENGINEERING SHALL BE PROVIDED BY BIDDER WITHOUT ANY COMMERCIAL/TECHNICAL IMPLICATION. 2. CONTRACTOR TO SUBMIT REUSABLE DATABASE FORMATS IN BHEL/CUSTOMER APPROVED FORMATS LIKE MS EXCEL,MS ACCESS OF DOCUMENTS LIKE INSTRUMENT SCHEDULE, I/O LIST, DRIVE LIST,FIELD JB TERMINATIONS, CABLE SCHEDULE & INTERCONNECTION, etc. SOFT COPY OF FORMATS SHALL BE PROVIDED TO SUCCESSFUL BIDDER.

DATA SHEETS FOR MOTORISED VALVE ACTUATOR

BHEL	**SPECIFICATION FOR MOTORISED VALVE ACTUATOR**	REV. NO. 01 / DATE: 11.05.2018
		SHEET 1 OF 4

Data Sheet A & B

	DATA SHEET-A (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
GENERAL*	* PROJECT	3 x 800 MW PATRATU TPP
	OFFER REFERENCE	
	* TAG NO. SERVICE	
	* DUTY	☐ ON / OFF ☐ INCHING
	* LINE SIZE (inlet/outlet): MATERIAL	
	* VALVE TYPE	☐ GLOBE ☐ GATE ☐ REG. GLOBE ☐ BUTTERFLY
	* OPENING / CLOSING TIME	
	* WORKING PRESSURE	
	AMBIENT CONDITION	SHALL BE SUITABLE FOR CONTINUOUS OPERATION UNDER AN AMBIENT TEMP. OF 0-55 DEG C AND RELATIVE HUMIDITY OF 0-95%
	VALVE SEAT TEST PRESS	BIDDER TO SPECIFY
	REQUIRED VALVE TORQUE	BIDDER TO SPECIFY
	ACTUATOR RATED TORQUE	BIDDER TO SPECIFY
CONSTRUCTION AND SIZING	CONSTRUCTION	TOTALLY ENCLOSED, WEATHER PROOF, IP:55
	MECHANICAL POSITION INDICATOR	TO BE PROVIDED FOR 0-100% TRAVEL
	BEARINGS	DOUBLE SHIELDED, GREASE LUBRICATED ANTI-FRICTION.
	GEAR TRAIN FOR LIMIT SWITCH/TORQUE SWITCH OPERATION	METAL (NOT FIBRE GEARS). SELF-LOCKING TO PREVENT DRIFT UNDER TORQUE SWITCH SPRING PRESSURE WHEN MOTOR IS DE-ENERGIZED.
	SIZING	OPEN/CLOSE AT RATED SPEED AGAINST DESIGNED DIFFERENTIAL PRESSURE AT 90% OF RATED VOLTAGE. FOR ISOLATING SERVICE THREE SUCCESSIVE OPEN-CLOSE OPERATIONS OR 15 MINS. WHICHEVER IS HIGHER. **FOR INCHING /REGULATING SERVICE - 150 STARTS/HR MINIMUM.**
HANDWHEEL	* REQUIRED	■ YES ☐ NO
	* ORIENTATION	☐ TOP MOUNTED ☐ SIDE MOUNTED
	*TO DISENGAGE AUTOMATICALLY DURING MOTOR OPERATION.	
ELECTRIC ACTUATOR	ACTUATOR MAKE/MODEL	BIDDER TO SPECIFY
	MOTOR MAKE / MODEL / TYPE / RATING (KW)	BIDDER TO SPECIFY
	@ MOTOR TYPE	SQUIRREL CAGE INDUCTION MOTOR, STARTING CURRENT LIMITED TO SIX TIMES THE RATED CURRENT-INCLUSIVE OF **I.S.** TOLERANCE
	ACTUATOR APPLICABLE WIRING DIAGRAM	■ ENCLOSED (BIDDER TO CONFIRM) A: ☐ DRG. NO. 3-V-MISC-24227 R00 B: ☐ DRG. NO. 3-V-MISC-24550 R00 C: ☐ DRG. NO. 3-V-MISC-24283 R00 D: ☐ DRG. NO. 4-V-MISC-90271 R11 E: ☐ For Thyristor based Integral starter, Bidder/Vendor to furnish wiring diagram
	COLOUR SHADE	■ BLUE (RAL 5012) ENAMEL ☐ .....
	PAINT TYPE **(## Refer Notes)**	☐ ENAMEL ☐ EPOXY ☐ .....
	SHAFT RPM	BIDDER TO SPECIFY
	OLR SET VALVE	BIDDER TO SPECIFY
	@ STARTING / FULL LOAD CURRENT	BIDDER TO SPECIFY
	NO. OF REV FOR FULL TRAVEL	BIDDER TO SPECIFY
	@ PWR SUPP TO MTR / STARTER	415V +/- 10 % , 3PH,3 W, AC 50 HZ +/- 5 %
	@ CONTROL VOLTAGE REQUIREMENT	TO BE DERIVED FROM THE POWER SUPPLY TO THE STARTER ☐ 230 V ■ 110 V AC/24V DC

BHEL	**SPECIFICATION FOR MOTORISED VALVE ACTUATOR**	REV. NO. 01 DATE: 11.05.2018 SHEET 2 OF 4

Data Sheet A & B

	DATA SHEET-A (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)	
	MOTOR BEARING WITH 2 EARTH TERMINALS	DOUBLE SHIELDED, GREASE LUBRICATED ANTI FRICTION	
	@ ENCLOSURE CLASS OF MOTOR	IP 67 FOR OUTDOOR & IP 55 FOR INDOOR(TOTALLY ENCLOSED SELF VENTILATED)	
	@ INSULATION CLASS	CLASS-F TEMP. RISE LIMITED TO CLASS-B	
	@ WINDING TEMP PROTECTION	■ THERMOSTAT (3 Nos.,1 IN EACH PHASE) ☐ ----------	
	SINGLE PHASE / WRONG PHASE SEQUENCE PROTECTION	REQUIRED	
INTEGRAL STARTER	INTEGRAL STARTER	■ REQUIRED ☐ NOT REQUIRED	
	TYPE OF SWITCHING DEVICE	■ CONTACTORS ☐ THYRISTORS	
	TYPE	■CONVENTIONAL ☐ SMART (NON-INTRUSIVE)	
	IF SMART	(NOT APPLICABLE)	
	a) SERIAL LINK INTERFACE	☐ INTEGRAL ☐ FIELD MOUNTED	
	b) SERIAL LINK PROTOCOL	☐ FOUNDATION FIELD-BUS ☐ PROFI-BUS ☐ DEVICE NET ☐.....	
	c) SERIAL LINK MEDIA	☐ TWISTED PAIR Cu-CBL ☐ CO-AXIAL Cu-CBL ☐ OFC	
	d) HAND HELD PROGRAMMER	☐ REQUIRED ☐ NOT REQUIRED	
	e) TYPE OF HAND HELD PROGRAMMER	☐ BLUETOOTH ☐ INFRARED ☐.....	
	f) MASTER STATION	☐ REQUIRED ☐ NOT REQUIRED	
	g) MASTER STN INTRFACE WITH DCS	☐ MODBUS ☐ TCP/IP	
	h) DETAILS OF SPECIAL CABLE	☐ ENCLOSED ☐ NOT REQUIRED	
	STEP DOWN CONT. TRANSFORMER	■ REQUIRED	
	OPEN / CLOSE PB	■ REQUIRED ☐ NOT REQUIRED	
	STOP PB	■ REQUIRED ☐ NOT REQUIRED	
	INDICATING LAMPS	■ REQUIRED ☐ NOT REQUIRED	
	LOCAL REMOTE S/S	■REQUIRED ☐ NOT REQUIRED	
	STATUS CONTACTS FOR MONITORING	■ REQUIRED ☐ NOT REQUIRED	
	INTEGRAL STARTER DISTURBED SIGNAL	REQUIRED (O/L RELAY OPERATED, CONT./POWER SUPPLY FAILED, S/S IN LOCAL, TORQUE SWITCH OPTD. MID WAY)	
INTERPOSING RELAY/OPTO COUPLER (Applicable for integral Starter)	TYPE OF ISOLATING DEVICE	■ INTERPOSING RELAY ☐ OPTO COUPLER ☐ EITHER	
	QUANTITY	■ 2 NOs. ☐ 3 NOs.	
	DRIVING VOLTAGE	■ 20.5 – 24V DC ☐ _____V DC	
	DRIVING CURRENT	■ 125mA MAX ☐ _____mA MAX	
	LOAD RESISTANCE	■ > 192 ohms - <25 k ohms ☐ > _____ohms - < _____ohms	
TORQUE SWITCH (Not Applicable for Smart Actuator) **($$ Refer Notes)**	MFR & MODEL NO.	BIDDER TO SPECIFY	
	OPEN / CLOSE	■1 No. ☐2Nos. / ■1 No. ☐2Nos	
	CONTACT TYPE	2 NO + 2 NC	
	RATING	5A 240V AC AND 0.5A 220V DC	
	CALIBRATED KNOBS(OPEN&CLOSE TS)	REQUIRED FOR SETTING DESIRED TORQUE	
	ACCURACY	+3% OF SET VALUE	
LIMIT SWITCH (Not Applicable for Smart Actuator) ($$	MFR & MODEL NO.	BIDDER TO SPECIFY	
	OPEN : INT : CLOSE	☐1 No ■2 Nos. : : ☐1 No. ■2Nos.	
	CONTACT TYPE	2 NO + 2 NC	

BHEL	**SPECIFICATION FOR MOTORISED VALVE ACTUATOR**	REV. NO. 01 DATE: 11.05.2018 SHEET 3 OF 4

Data Sheet A & B

DATA SHEET-A (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)

Refer Notes)	RATING (AC / DC)	5A 240V AC AND 0.5A 220V DC	
Limit switches shall be silver plated with high conductivity and non-corrosive type. Contact rating shall be sufficient to meet the requirement of control system subject to a minimum of 60 V, 6 VA rating. Protection class shall be IP 55.			

POSITION TRANSMITTER	POSITION TRANSMITTER (For inching duty applications)	■ REQUIRED ☐ NOT REQUIRED	
	MFR & MODEL NO.	BIDDER TO SPECIFY	
	TYPE	☐ELECTRONIC (2 WIRE) R/I CONVERTER ■ ELECTRONIC (2 WIRE) CONTACTLESS INDCUTIVE TYPE ,EXTERNAL 24 V DC OPERATED ,SUITABLE FOR STABILISED 4-20 mA SIGNAL	
	SUPPLY	■ 24V DC ☐	
	OUTPUT	■ 4-20mA	
	ACCURACY	± 1% FS	
SPACE HEATER	@SPACE HEATER	REQUIRED	
	@ POWER SUPPLY (NON INTEGRAL)	230V AC,1 PH.,50 Hz	
	@ POWER SUPPLY (INTEGRAL)	POWER SUPPLY DERIVED FROM MAIN POWER SUPPLY AVAILABLE AT ACTUATOR END.	
	@ RATING		
TERMINAL BOX	ACTUATOR/MOTOR TERMINAL BOX	REQUIRED	
	ENCL CLASS ACTUATOR/MOTOR T.B.	■ IP 68 @☐.....	
	@ EARTHING TERMINAL	REQUIRED	
	PLUG & SOCKET(9 PIN) (FOR COMMD, LS/TS FEED BACK, PoT)	■ REQUIRED ☐ NOT REQUIRED☐ ■ 2 NOS. PRE WIRED ☐ ----------	
CABLE GLANDS	@ POWER CABLE GLAND	SIZE:----------	
	@ SPACE HEATER CABLE GLAND	SIZE:----------	
	OTHER CONTROL CABLE GLANDS-1	2 NOS SUITABLE FOR 4P,0.5SQ MM	
	OTHER CONTROL CABLE GLAND	1 No. for BFV of CW PUMP(Cable size 2Px1.5mm2)	

BHEL	**SPECIFICATION FOR MOTORISED VALVE ACTUATOR**	REV. NO. 01 DATE: 11.05.2018 SHEET 4 OF 4

Data Sheet A & B

DATA SHEET-A (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)

WEIGHT	TOTAL WEIGHT (ACTUATOR + ACCESSORIES)	BIDDER TO SPECIFY	_____ Kg.

NOTES:

1. **SCOPE**: DESIGN, MANUFACTURE, INSPECTION, TESTING AND DELIVERY TO SITE OF ELECTRIC ACTUATOR FOR INCHING OR OPEN / CLOSE DUTY.
2. **CODES & STANDARDS**: DESIGN AND MATERIALS USED SHALL COMPLY WITH THE RELEVANT LATEST NATIONAL AND INTERNATION STANDARD. AS A MINIMUM, THE FOLLOWING STANDARDS SHALL BE COMPLIED WITH:
   IS-9334, IS-2147, IS-2148, IS-325, IS-2959, IS-4691 AND IS-4722
3. TEMPERATURE RISE SHALL BE RESTRICTED TO 70 DEG. C FOR AMBIENT TEMPERATURE OF 50 DEG C.
4. CABLE GLANDS OF DOUBLE COMPRESSION TYPE, BRASS MATERIAL SHALL BE PROVIDED.
5. THE TORQUE SWITCHES SHALL BE PROVIDED WITH MECHANICAL LATCHING DEVICE TO PREVENT OPERATION WHEN UNSEATING FROM THE END POSITIONS. THE LATCHING DEVICE SHALL UNLATCH AS SOON AS THE VALVE LEAVES THE END POSITION. IF SUCH PROVISION IS NOT POSSIBLE, THE TORQUE SWITCHES SHALL BE BYPASSED BY END-POSITION LIMIT SWITCHES WHICH OPENS ON VALVE LEAVING END POSITION.THESE LIMIT SWITCHES ARE ADDITIONAL TO THE NUMBER OF LIMIT SWITCHES SPECIFIED ELSEWHERE.
6. THE MOTOR SHALL OPERATE SATISFACTORILY UNDER THE +/- 10% SUPPLY VOLTAGE VARIATION AT RATED FREQUENCY, -5% TO +3% VARIATION IN FREQUENCY AT RATED SUPPLY VOLTAGE, SIMULTANEOUS VARIATION IN VOLTAGE & FREQUENCY THE SUM OF ABSOLUTE PERCENTAGE NOT EXCEEDING 10%.
7. THE MOTOR SHALL BE SUITABLE FOR DIRECT ON LINE STARTING.

$$ TORQUE SWITCH & LIMIT SWITCH SHALL ACT INDEPENDENT OF EACH OTHER. TANDEM OPERATION IS NOT ACCEPTABLE.

EPOXY PAINT IS RECOMMENDED FOR COASTAL AREAS.

8. IT SHALL BE POSIIBLE TO OPERATE THE ACTUATOR LOCALLY. LOCKABLE LOCAL/REMOTE SELECTION SHALL BE PROVIDED ON THE ACTUATOR.
9. POSITION INDICATOR SHALL BE PROVIDED FOR 0 TO 100 % TRAVEL
10. WIRING SHALL BE SUITABLE VOLTAGE GRADE COPPER WIRE.

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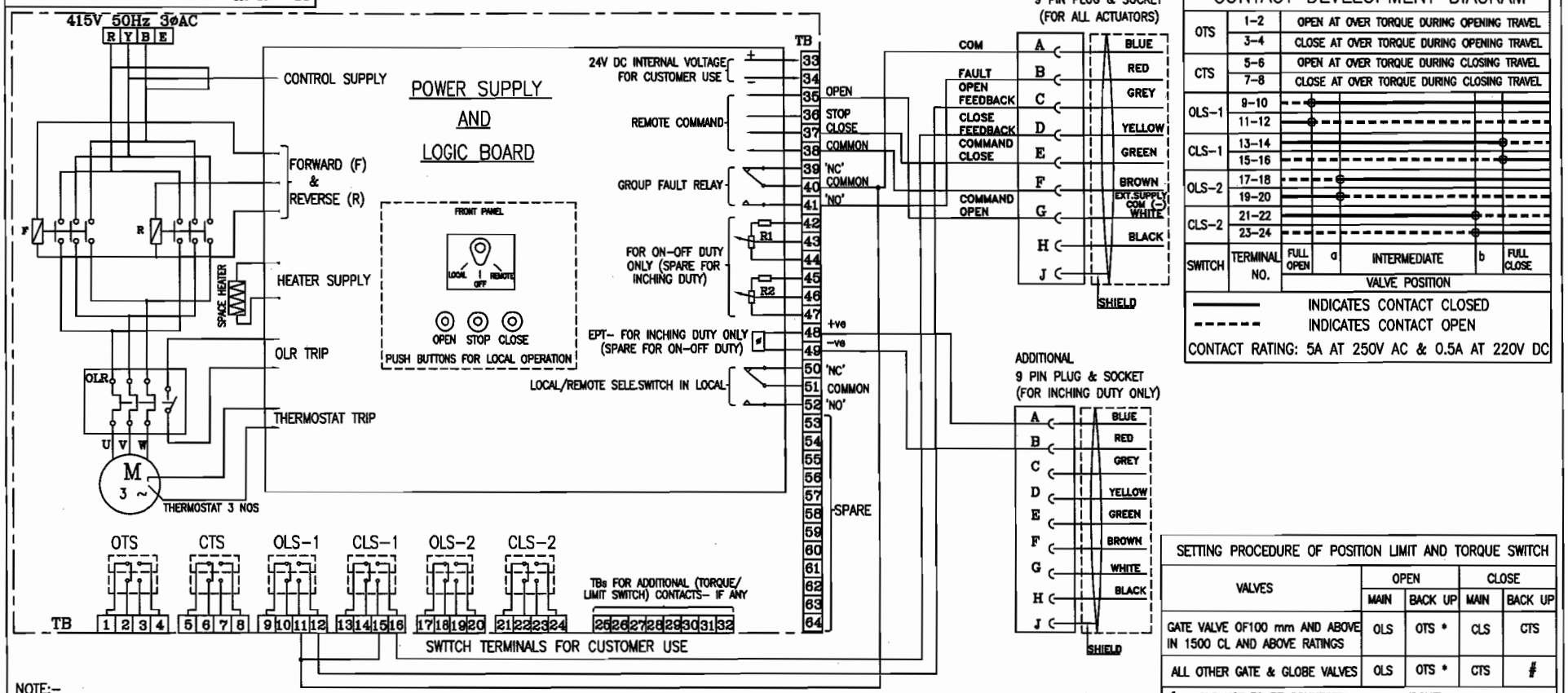
	PREPARED BY	CHECKED BY	APPROVED BY	VENDOR COMPANY SEAL
NAME	Madhav gupta	Mayank kesharwani	Bharat Singh	NAME
SIGNATURE				SIGNATURE
DATE	01.03.02018 01.	03.2018	01.03.2018	DATE

NOTES* = TO BE FILLED BY MPL (LEAD AGENCY). @= TO BE FILLED BY ES

ALL DIMENSIONS ARE IN MILLIMETRES. FOR TOLERANCES OF UNTOLERANCED DIMENSIONS DURING MANUFACTURE REFER RELEVANT QCP / QP.

DRAWING NO. 3-V-MISC-24283



CONTACT DEVELOPMENT DIAGRAM

OTS	1-2	OPEN AT OVER TORQUE DURING OPENING TRAVEL
	3-4	CLOSE AT OVER TORQUE DURING OPENING TRAVEL
CTS	5-6	OPEN AT OVER TORQUE DURING CLOSING TRAVEL
	7-8	CLOSE AT OVER TORQUE DURING CLOSING TRAVEL
OLS-1	9-10	
	11-12	
CLS-1	13-14	
	15-16	
OLS-2	17-18	
	19-20	
CLS-2	21-22	
	23-24	

SWITCH TERMINAL NO. — FULL OPEN | a | INTERMEDIATE | b | FULL CLOSE — VALVE POSITION

INDICATES CONTACT CLOSED

INDICATES CONTACT OPEN

CONTACT RATING: 5A AT 250V AC & 0.5A AT 220V DC

SETTING PROCEDURE OF POSITION LIMIT AND TORQUE SWITCH

VALVES	OPEN		CLOSE	
	MAIN	BACK UP	MAIN	BACK UP
GATE VALVE OF100 mm AND ABOVE IN 1500 CL AND ABOVE RATINGS	OLS	OTS *	CLS	CTS
ALL OTHER GATE & GLOBE VALVES	OLS	OTS *	CTS	#

– CLS NOT TO BE CONNECTED IN TRIP CIRCUIT

* – BYPASS OTS FOR INITIAL 5% OF TRAVEL(FOR GATE VALVES ONLY)

NOTE:-

1. ALL TORQUE AND LIMIT SWITCHES (OTS,CTS,OLS1&2, CLS1&2) ARE WITH 2NO+2NC CONTACTS '1NO+1NC' IS TERMINATED IN TBS 1-24, REMAINING CONTACTS ARE FOR INTERNAL USE. ANY SPARE CONTACTS WHICH ARE NOT USED INTERNALLY ARE TO BE TERMINATED IN TBS 25-32
2. CTS – TORQUE SWITCHES FOR CW ROTATION (CLOSE)
3. OTS – TORQUE SWITCHES FOR CCW ROTATION (OPEN)
4. OLS-1, OLS-2 – LIMITSWITCHES FOR POSITION OPEN
5. CLS-1, CLS-2 – LIMITSWITCHES FOR POSITION CLOSE
6. EPT – ELECTRONIC POSITION TRAMSMITTER (CONTACTLESS TYPE, FOR INCHING DUTY)
7. R1-R2-POTENTIOMETER 2 x 100 OHMS (FOR ON-OFF DUTY)
8. FOR COMMANDS & EPT EITHER INTERNALLY GENERATED 24 VDC OR EXTERNAL SUPPLY OF 24VDC CAN BE USED
9. M – MOTOR 3ø 415V 50 Hz AC SUPPLY
10. TORQUE SWITCH BYPASS WITH LIMITSWITCH BOTH ON OPEN & CLOSE DIRECTION TO BE DONE INTERNALLY.

REV	DATE	ALTERED
		CHD & APPD

CAUTION: The information on this document is the property of BHARAT HEAVY ELECTRICALS LTD. It must not be used directly or indirectly in any way detrimental to the interest of the company.

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT: ELECTRICAL VALVE ACTUATORS (AC) WITH INTEGRAL STARTERS FOR NTPC PROJECTS (DRAWN FOR INTERMEDIATE POSITION OF VALVES)

BHARAT HEAVY ELECTRICALS LTD., UNIT: HIGH PRESSURE BOILER PLANT. TIRUCHIRAPALLI-620014. 365-121

	NAME	SIGN	DATE	NO.OF VAR.
DRN	N.P.ESWAR	N.P	17.03.05	-
CHD	D.DINAKARAN	D.D	17.03.05	
APPD	K.ARUNACHALAM	K.A	17.03.05	

DEPT	SCALE	WEIGHT (KG).	REFERENCE INFORMATIONS	NO. OF ITEMS
VL	NTS	-		-
CODE -				

TITLE: WIRING DIAGRAM (TERMINAL PLAN) FOR ACTUATOR WITH INTEGRAL STARTER WITH PLUG & SOCKET FOR NTPC PROJECTS

CARD CODE: U 01

DRAWING NO. 3-V-MISC-24283

REV 0

Size A3

CLAUSE

ELECTRICAL ACTUATORS WITH INTEGRAL STARTERS

1.00.00 **CODES AND STANDARDS:**

1.01.00 All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions. In case of conflict between this specification and codes, standards, etc, the former shall prevail.

2.00.00 **ELECTRIC ACTUATORS WITH INTEGRAL STARTERS**

2.01.00 **TYPE:**

2.01.01 The actuators shall have integral starters along with over load relays with built in SPP (Single Phasing Preventer). Alternatively Smart non intrusive actuators are also acceptable. A 415, 3 phase 3 wire power supply shall be given to the actuator from switch board as applicable through a switch fuse unit. Control voltage of the motor starter shall be 110 V AC / 24 V DC, derived suitably from 415V power supply.

2.01.02 In case supplier's standard control voltage for Open/Close contactors is 110V AC, the same is acceptable if suitable Opto Isolation circuit is provided with coupling relays for 24 V DC command inputs.

2.02.00 **INTERFACES:**

2.02.01 Open/Close command termination logic with position & torque Limit Switches, positioner circuit shall be suitably built in the PCB inside the actuator.

(a) For Binary Drive (both ON-OFF and INCHING type) :- Open/Close command & status thereof and disturbance monitoring signal (common contact for Overload, Thermostat, control supply failure, L/R selector switch at local & other protections operated) shall be provided.

Interface with the control system shall be through hardware signal only. Inter posing relays provided (with coil burden 2.5 VA) in the actuator shall be energized to initiate opening and closing, by 24V DC signal from the external control system.

(b) For Modulating Drive:- the command to actuator shall be in form of 4-20mA signal. The necessary positioning circuit and motor protection shall be provided

(c) Open/close command termination logic shall be suitably built inside actuator.

2.03.00 **RATING :**

(a) Supply Voltage & frequency: 415V +/- 10%, 3 Phase, 3 Wire 50HZ +/-5%.

(b) Sizing:-

Open/Close at rated speed against designed differential pressure at 90% of rated voltage.

For isolating service:- Three successive open-close operations or 15 mins, whichever is higher. For regulating service 150 starts per hour or required cycles, whichever is higher.

2.04.00 **CONSTRUCTION:**

(a) Enclosure:

Totally enclosed weatherproof minimum IP-55 degree of protection.

(b) Gear Train :

Metal (Fibre gears are not acceptable)) self-locking to prevent drift under torque switch (where ever applicable) spring pressure when motor is de-energized.

(c) Manual Wheel:

Shall disengage automatically during motor operation.

2.05.00 MOTOR :

(a) Type :

Squirrel cage induction motor suitable for Direct On Line (DOL)starting.

(b) Enclosure:

Totally enclosed, self ventilated IP-55 degree of protection.

(c) Insulation

Class B or better. Temperature rise 70 Deg C. over 50 Deg C ambient

(d) Bearings:

Double shielded, grease lubricated antifriction.

(e) Earth Terminals:

Two

(f) Protection:

Single Phasing Protection, Over heating protection through Thermostat (as applicable) and wrong phase sequence protection shall be provided over and above other protection features standard to bidder's design Suitable means shall be provided to diagnose the type of fault locally.

2.06.00 POSITION/TORQUE SWITCHES:

2.06.01 Four nos. (2 each in open and close position) position limit switches/contacts and two nos. (one in open and other in close direction) torque switches/contacts each having two nos. NO and two nos. NC contacts shall be provided.

Torque switches/contacts shall be bypassed in both the end positions with the other end Limit switches/contacts.

Limit switches/contacts

Limit switches shall be Silver plated with high conductivity and non –corrosive type. Contact rating shall be sufficient to meet the requirement of Control System subject to a minimum of 60 V, 6 VA rating. Protection class shall be IP-55.

	Limit switch/contacts and disturbance signals shall be available to DCS even when the power supply to the actuators is not available.
2.07.00	**LOCAL OPERATION:**
2.07.01	It shall be possible to operate the actuator locally also. Lockable local/remote selection shall be provided on the actuator.
2.08.00	**POSITION INDICATOR :**
2.08.01	To be provided for 0 to 100% travel.
2.09.00	**POSITION TRANSMITTER (FOR MODULATING/INCHING TYPE) :**
2.09.01	As required. Suitable for stabilized 4-20 mA signal, 2 wire inductive type, External 24 volts DC operated.
2.10.00	**WIRING :**
2.10.01	Suitable voltage grade copper wire.
2.11.00	**TERMINAL BOX :**
	(i) 9 pin plug and socket (1 no. per actuator to suit 4 pair 0.5 sq.mm. copper overall shielded (16 mm OD), instrumentation cable) suitably mounted in the starter box itself to terminate open/close command and status feedback signals with external control systems.
	(ii) Additional one number 9 pin plug and socket (to suit 4 pair 0.5 sq.mm copper (16 mm OD) individual and overall shielded instrumentation cable) suitably mounted in the starter box itself for actuators with 4-20 mA position transmitters.
	(iii) Necessary glands for power cables shall be provided.
2.12.00	**TERMINAL BLOCK :**
2.12.01	650V grade. For power cables.
2.13.00	**SPACE HEATER :**
2.13.01	Space heater of suitable rating. The supply shall be derived from the main power supply available in the actuator.
2.14.00	**TYPICAL WIRING DIAGRAM :**
2.14.01	Refer Tender Drawing No. 0000-999-POI-A-063.

CONTROL VALVES, ACTUATORS & ACCESSORIES

1.00.00	**CONTROL VALVES, ACTUATORS & ACCESSORIES**
1.01.00	**General Requirements**
1.01.01	The control valves and accessories equipment furnished by the Bidder shall be designed, constructed and tested in accordance with the latest applicable requirements of code for pressure piping ANSI B 31.1, the ASME Boiler & pressure vessel code, Indian Boiler Regulation (IBR), ISA, and other standards specified elsewhere as well as in accordance with all applicable requirements of the "Federal Occupational Safety and Health Standards, USA" or acceptable equal standards. All the Control Valves, their actuators and accessories to be furnished under this Sub-section will be fully suitable and compatible with the modulating loops covered under the Specification.
1.01.02	All the control valves and accessories offered by the Bidder shall be from reputed, experienced manufacturers of specified type and range of valves.
1.01.03	For special type of control valves such as combined pressure and temperature control valves for Aux PRDS application, separator drain control valves, refer to the corresponding mechanical sections.
1.01.04	Specification for control valves in this Sub-section has to be read in conjunction with other relevant Sub-sections of this specification.
1.02.00	**CONTROL VALVE SIZING & CONSTRUCTION**
1.02.01	The design of all valve bodies shall meet the specification requirements and shall conform to the requirements of ANSI (USA) for dimensions, material thickness and material specification for their respective pressure classes.
1.02.02	The valve sizing shall be suitable for obtaining maximum flow conditions with valve opening at approximately 80% of total valve stem travel and minimum flow conditions with valve stem travel not less than 10% of total valve stem travel. All the valves shall be capable of handling at least 120% of the required maximum flow. Further, the valve stem travel range from minimum flow condition to maximum flow condition shall not be less than 50% of the total valve stem travel. The sizing shall be in accordance with the latest edition of ISA handbook on control valves. While deciding the size of valves, Bidder shall ensure that valves outlet velocity as defined in ISA handbook does not exceed 8 m/sec for liquid services, 150 m/sec. for steam services and 50% of sonic velocity for flashing services. Bidder shall furnish the sizing calculations clearly indicating the outlet velocity achieved with the valve size selected by him as well as noise calculations, which will be subject to Employer's approval during detailed engineering.
1.02.03	Control valves for steam and water applications shall be designed to prevent cavitation, wire drawing, flashing on the downstream side of valve and down stream piping. Thus for cavitation/flashing service, only valve with anti cavitation trim shall be provided. Detailed calculations to establish whether cavitation will occur or not for any given application shall be furnished.
1.02.04	Control valves for application such as SH Spray Control, RH spray Control, Heavy Oil Heating, pressurizing and Control system, HP/LP heater Emergency level control, Emergency Make-up to condenser hotwell, GSC minimum flow, Deaerator Drain to Condenser Hotwell, Condensate spill to condensate reserve tank, condenser normal make-up and valve gland sealing supplying pressure control, CEPS minimum flow control, **BFP circulation control valve** shall have permissible leakage rate as per leakage Class V. All other control valves shall have leakage rate as per leakage Class-IV **as per ANSI / FCI /70.2,2006 or equivalent**.

1.02.05 The control valve induced noise shall be limited to 85 dBA at 1 meter from the valve surface under actual operating conditions. The noise abatement shall be achieved by valve body and trim design and not by use of silencers except for few cases as per contractor's standard and proven practice subject to employer's approval.

1.02.06 Control valves for steam and water application shall be provided with rangability of 30:1 for all services except for applications wherein control valves are envisaged to be operated in lower range like Reheater spray and superheater spray system wherein control valve with rangability of 50:1 shall be provided

2.00.00 VALVE CONSTRUCTION

2.01.00 All valves shall be of globe body design & straightaway pattern with single or double port, unless other wise specified or recommended by the manufacturer to be of angle body type. Rotary valve may alternatively be offered when pressure and pressure drops permit.

2.02.00 Valves with high lift cage guided plugs & quick-change trims shall be supplied.

2.03.00 Cast Iron valves are not acceptable.

2.04.00 Bonnet joints for all control valves shall be of the flanged and bolted type or other construction acceptable to the Employer. Bonnet joints of the internal threaded or union type will not be acceptable.

2.05.00 Plug shall be of one-piece construction cast, forged or machined from solid bar stock. Plug shall be screwed and pinned to valve stems or shall be integral with the valve stems.

2.06.00 All valves connected to vacuum on down stream side shall be provided with packing suitable for vacuum applications (e.g. double vee type chevron packing)

2.07.00 Valve characteristic shall match with the process characteristics.

2.08.00 Extension bonnets shall be provided when the maximum temperature of flowing fluid is greater than 280 deg. C.

2.09.00 Flanged valves shall be rated at no less then ANSI press class of 300 lbs.

3.00.00 VALVE MATERIALS

Sr. No.	Service	Body material	Trim Material
1	Non-corrosive, non-flashing and non-cavitation service except DM water	Carbon steel ASTM-A216 Gr. WCB for design fluid temperature below 275 Deg. C Alloy steel ASTM-A217Gr. WC6 for design fluid temperature above 275 Deg. C and upto 400 Deg. C Alloy steel ASTM-A217Gr. WC9 for design fluid temperature above 400 Deg. C	316SS stellited with stellited faced guide posts and bushings.
2.	Severe flashing/cavitation services	Alloy steel ASTM-A217 Gr. WC9	440 C

3.	Low flashing/cavitation service	Alloy steel ASTM-A217 Gr. WC6	17-4 PH SS
4.	DM water service	316 SS	316 SS

NOTE: (a) Valve body rating shall meet the process pressure and temperature requirement as per ANSI B16.34.

(b) Severe flashing / cavitation services includes as a minimum all control valves whose downstream piping is connected to condenser or flash tank.

However, Bidder may offer valves with body and trim materials better than specified materials and in such cases Bidder shall furnish the comparison of properties including cavitation resistance, hardness, tensile strength, strain energy, corrosion resistance and erosion resistance etc. of the offered material vis-a-vis the specified material for Employer's consideration and approval.

Contractor shall ensure that all required measures like proper selection of anti-corrosive/erosive material along with durable epoxy coating with polyurethane finish shall be provided for all the C&I equipment/ devices being supplied in this contract, which are mounted in non-AC areas (prone to sea water environment corrosion / erosion) like measuring instruments, control valves & actuators, JBs, LIEs / LIRs, impulse pipes, sample pipes, fittings, conduits, cable trays and accessories, local control panels, erection hardware items etc. Contractor shall furnish their comprehensive proposal regarding the anti-corrosion/ erosion measures for protection against sea water environment which shall be finalized during detailed engineering subject to Employer's approval.

4.00.00 END PREPARATION

Valve body ends shall be either butt welded/socket welded, flanged (Rubber lined for condensate service) or screwed as finalized during detailed engineering and as per Employer's approval. The welded ends wherever required shall be butt welded type as per ANSI B 16.25 for control valves of sizes 65 mm and above. For valves size 50 mm and below welded ends shall be socket welded as per ANSI B 16.11. Flanged ends wherever required shall be of ANSI pressure-temperature class equal to or greater than that of the control valve body.

5.00.00 VALVE ACTUATORS

All control valves shall be furnished with pneumatic actuators except for pressure and temperature control valve for auxiliary PRDS application (electro-hydraulic / pneumatically operated) and separator drain control valve (electro-hydraulic type).The Bidder shall be responsible for proper selection and sizing of valve actuators in accordance with the pressure drop and maximum shut off pressure and leakage class requirements. The valve actuators shall be capable of operating at 60 deg.C continuously.

Valve actuators and stems shall be adequate to handle the unbalanced forces occurring under the specified flow conditions or the maximum differential pressure specified. An adequate allowance for stem force, at least 0.15 Kg/sq.cm. per linear millimeter of seating surface, shall be provided in the selection of the actuator to ensure tight seating unless otherwise specified.

The travel time of the pneumatic actuators shall not exceed 10 seconds.

6.00.00 **CONTROL VALVE ACCESSORY DEVICES**

6.01.00 All pneumatic actuated control valve accessories such as air locks, hand wheels/hand-jacks, limit switches, microprocessor based electronic Positioner, diffusers, external volume chambers, position transmitters (capacitance or resistance type only), reversible pilot for Positioner, tubing and air sets, solenoid valves and junction boxes etc. shall be provided as per the requirements.

7.00.00 **SPECIFICATIONS FOR MICROPROCESSOR BASED ELECTRONIC POSITIONER**

1	Electrical	a) Input Demand Signal	4-20 mA
		b) Power Supply	Loop Powered from the output card of Control System.
		c) HART Protocol	Compatibility for Remote Calibration & Diagnostics (Super-imposed HART signal on input Signal (4-20 mA)
		d. Valve position sensing	Position sensing, 4-20 mA output signal to be provided for control system.
2	Environment	a) Operating temp.	(-)30 To 80 Deg. C
		b) Humidity	0-95 %
		c) Protection class	IP-65 Minimum
3	Software for Configuration and Diagnostics	Software	Software shall meet the requirements for Configuration, Diagnostics, Calibration and Testing of the actuator.
		Diagnostic/Test features	Advanced diagnostic features like Stroke counter or Travel counter, Leakage in actuators, Valve Signature analysis, Step Response test, Valve friction /Jamming detection etc to be provided.
4	Test reports/ Certificates	Factory Valve Signature Tests Reports (Pr Vs Valve travel and Travel Vs I/P signal) are to be provided.	
		Test certificates as per Manufacture Standard/Relevant Standard are to be submitted.	
5	Configuration/ Calibration.	Remote & Local Calibration, Auto & Manual Calibration shall be possible.	
6	Operating Range	Full range/ Split range.	
7	Modes	Valve Action	Direct / Reverse Valve Action

		Flow Characterization	Possible to fit Valve Characteristic Curves- Linear , Equal percentage etc.
8	Fail Safe/Fail Freeze	Fail Safe/Fail Freeze feature is to be provided. (In case the fail freeze feature is not intrinsic to the positioner, Bidder shall achieve the same externally through solenoid valve connected in the pneumatic circuit).	
9	Pneumatic	Air capacity	Sufficient to handle the valves & actuators selected/ Boosters to be supplied, if required.
		Air pressure	To suit the air supply pressure/quality available.
		Process connection	¼" NPT
10	Performance	Characteristic deviation	<=0.5 % of span.
		Ambient temp effect	<=0.01 %/ deg C or better.
10	EMC & CE Compliance	Required to International Standard like EN/IEC.	EN50081-2 & EN50082 or equivalent.
11	Accessories	In-built Operator Panel	Display with push buttons for configuration and display on the positioner itself (Password protected/Hardware lock).
		Hand Held Hart Calibrator	Universal Hart Calibrator to be provided (for quantity, refer Part-A: Contract quantities of the specification).
		Press Gauge Block	For supply & output pressures, Air Filter Regulator and other accessories shall be provided on as required basis for making system complete.
		Electrical Cable Entry	1/2'"NPT, side or bottom entry to avoid water

			ingress.
		Valves Mounting Assembly	For Sliding Stem/Rotary/Single acting/Double acting actuators on as required basis

*** Note**:

The HART signals shall be picked up from marshalling terminals of DDCMIS (SG/TG DDCMIS as well as BOP DDCMIS), as applicable. The details of the above mentioned HART management system specification are mentioned in HART system (Annexure IIIC-02C to DDCMIS).

The positioners shall be monitored from this HART management system .To achieve this, Bidder shall provide the necessary software to achieve the functionalities described above under " Software for Configuration and Diagnostics", and this software shall be loaded in the HART management system.

8.00.00 TEST AND EXAMINATION

All valves shall be tested in accordance with the quality assurance programme agreed between the Employer and Contractor, which shall meet the requirements of IBR and other applicable codes mentioned elsewhere in the specifications. The tests shall include but not be limited to the following:

8.01.00 Non Destructive Test as per ANSI B-16.34.

8.02.00 Hydrostatic shell test in accordance with ANSI B 16.34 prior to seat leakage test.

8.03.00 Valve closure test and seat leakage test in accordance with ANSI-B 16.34/ FCI 70.2 standard and as per the leakage class indicated above

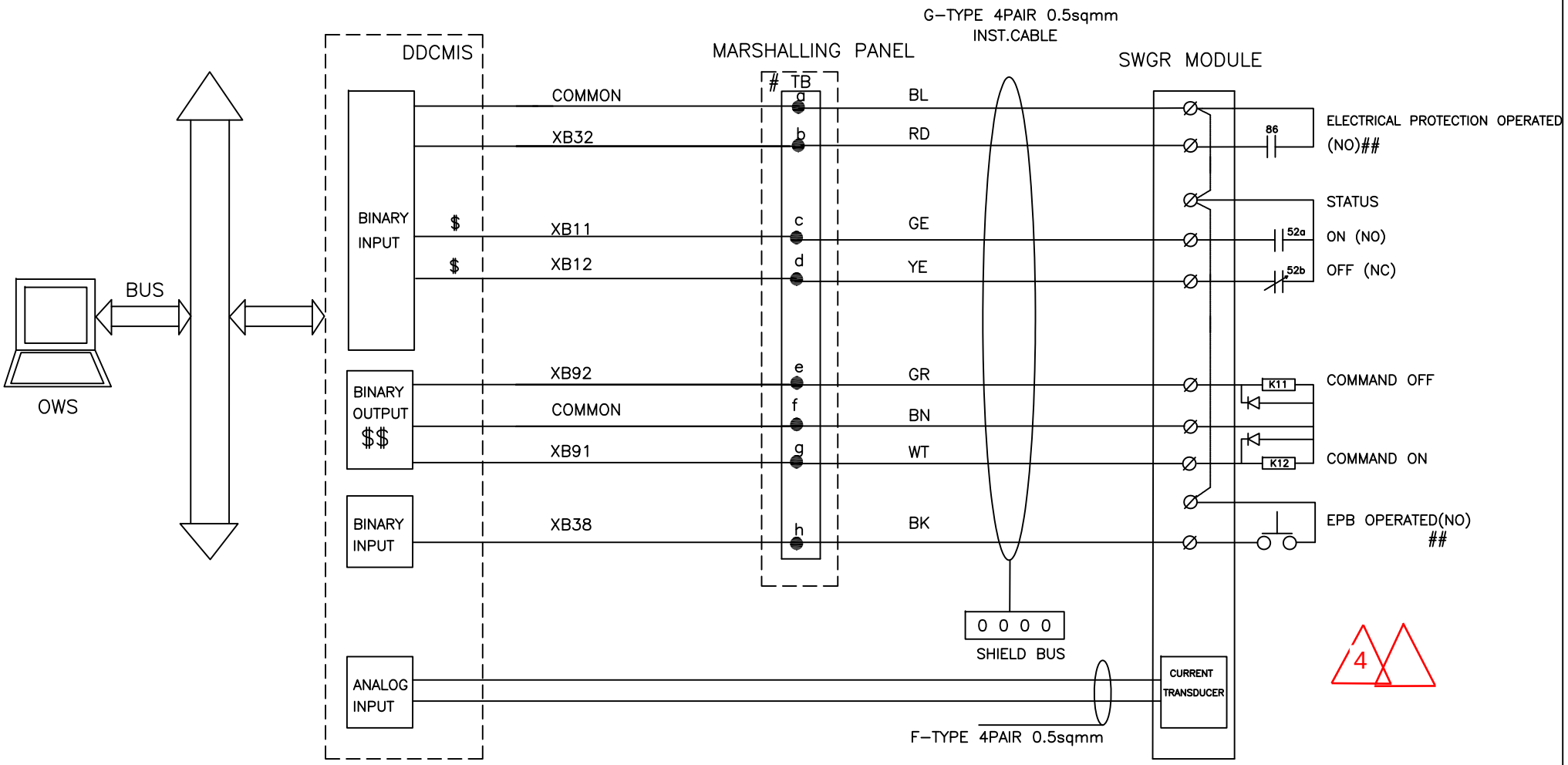
8.04.00 Functional Test: The fully assembled valves including actuators control devices and accessories shall be functionally tested to demonstrate times from open to close position.

8.05.00 CV Test: Please refer Cl No. 1.00.00 & 3.00.00 OF Sub-section- IIIC-10 (Type test requirements), Control Valves.

Bidder shall furnish all the control valves under this main plant package as finalized during detailed engineering stage without any price repercussions whatsoever depending on the process requirements. All the control valves provided by the Bidder for this project shall meet the specifications requirements specified herein. Specification for control valves in this Sub-section has to be read in conjunction with other relevant Sub-sections of this specification.

SIGNAL EXCHANGE BETWEEN DRIVES & DCS

DDCMIS INTERFACE WITH HT SWITCH GEAR (HT)



NOTE:–1 $ REDUNDANT INPUTS FOR UNIT DDCMIS ONLY

NOTE:–2 $$ REDUNDANT OUTPUTS WHEREVER APPLICABLE

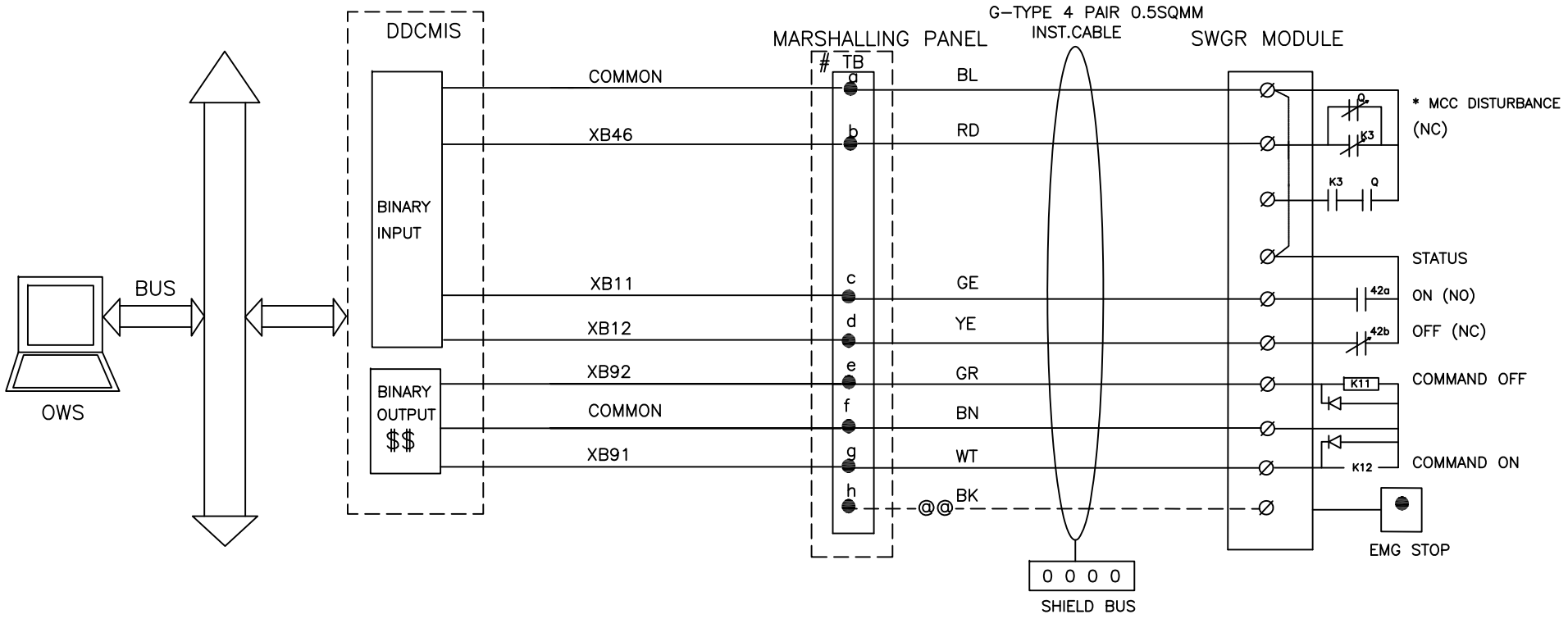
NOTE:–3 # 8 LEVEL TERMINAL BLOCK

NOTE:–4 ## DI–SOE SIGNALS FOR UNIT DDCMIS ONLY

NOTE:–5 CURRENT SIGNAL IS TO BE CONSIDERED IN DDCMIS FROM HT BREAKER FOR FD,ID,PA,MILL MOTORS, CHP HT CONVEYORS

BHEL	3X800 MW NTPC PATRATU STPP PHASE–I	DRG.NO.	9585–001–405–PVI–B–152B
	DDCMIS INTERFACE WITH HT SWITCH GEAR(HT)	SH	04 OF 34

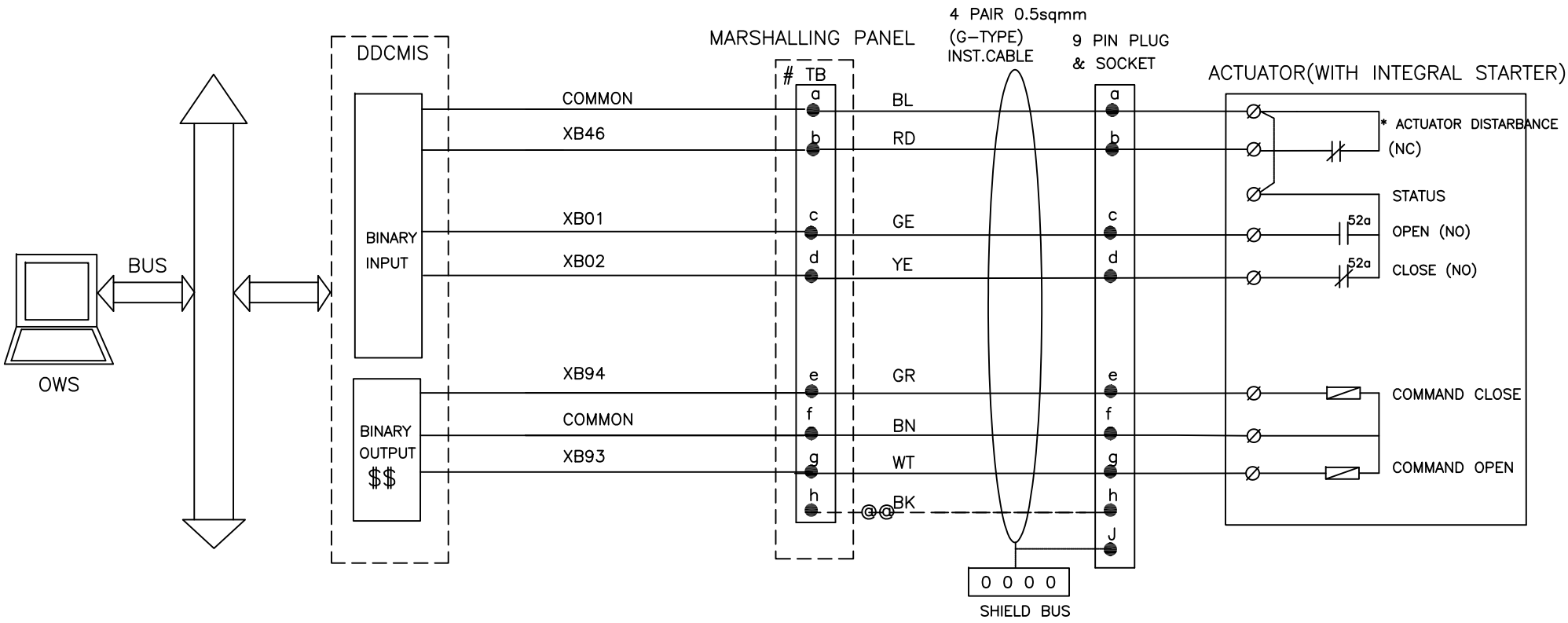
DDCMIS INTERFACE WITH LT MCC (LT)



NOTE:-1 $$ REDUNDANT OUTPUTS WHEREVER APPLICABLE
NOTE:-2 # 8 LEVEL TERMINAL BLOCK
NOTE:-3 @@ INEACH DDCMIS POST,UNUSED TB'S ARE USED FOR SPARE CORE TERMINATION SEQUENTIALLY.
NOTE:-4 * MCC DISTURBED= THERMAL O/L OPT/CONT SUPP FAIL/EPB OPTD /DRIVE POWER SUPPLY OFF

BHEL	3X800 MW NTPC PATRATU STPP PHASE-I	DRG.NO.	9585-001-405-PVI-B-152B
	DDCMIS INTERFACE WITH LT MCC (LT)	SHT	05 OF 34

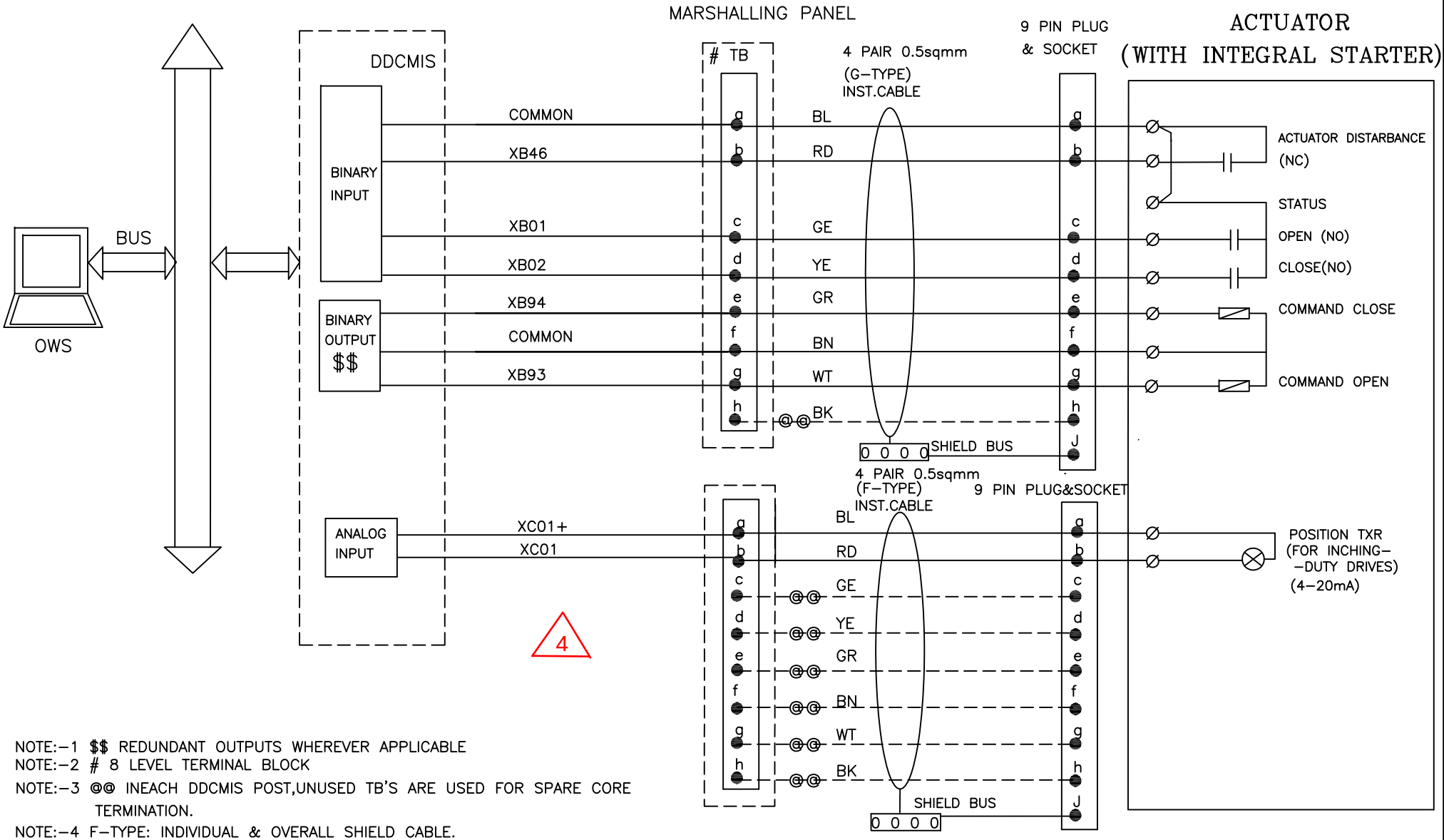
DDCMIS INTERFACE WITH BID/MOV/MOD



NOTE:-1 $$ REDUNDANT OUTPUTS WHEREVER APPLICABLE
NOTE:-2 # 8 LEVEL TERMINAL BLOCK
NOTE:-3 @@ INEACH DDCMIS POST,UNUSED TB'S ARE USED FOR SPARE CORE TERMINATION.
NOTE:-4 * DISTURBANCE=LOSS OF POWER SUPPLY(1PHASE/3PHASE)/LOSS OF CONTROL SUPPLY/MOTOR THERMOSTAT TRIP/THERMAL OVER LOAD/ TORQUE SWITCH OPERATED, LOCAL/OFF/REMOTE SWITCH IN LOCAL/OFF POSITION

BHEL	3X800 MW NTPC PATRATU STPP PHASE-I	DRG.NO.	9585-001-405-PVI-B-152B
	DDCMIS INTERFACE WITH BID	SHT	06 OF 26

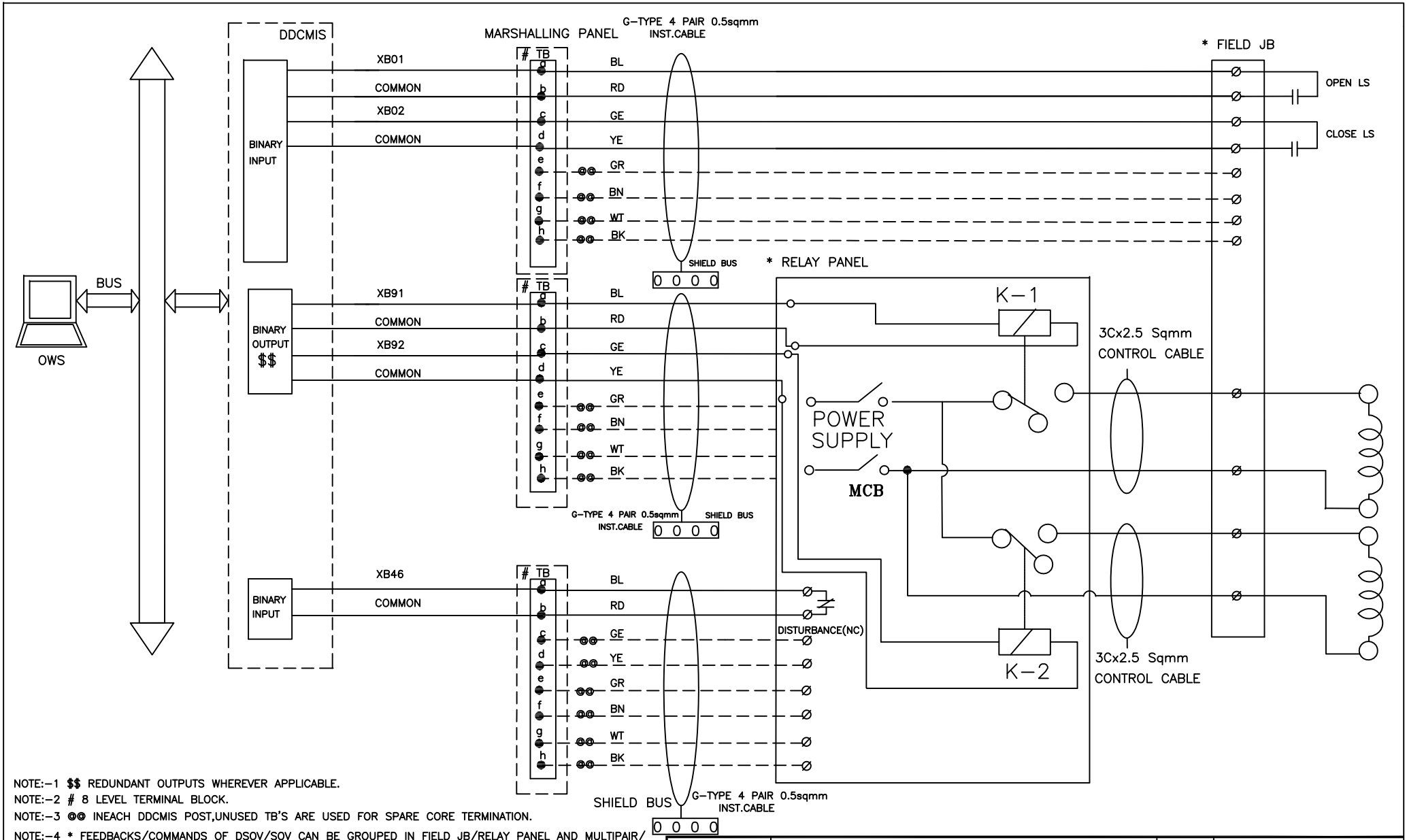
DDCMIS INTERFACE WITH BIDI/MODI/MOVI



NOTE:–1 $$ REDUNDANT OUTPUTS WHEREVER APPLICABLE
NOTE:–2 # 8 LEVEL TERMINAL BLOCK
NOTE:–3 @@ INEACH DDCMIS POST,UNUSED TB'S ARE USED FOR SPARE CORE TERMINATION.
NOTE:–4 F–TYPE: INDIVIDUAL & OVERALL SHIELD CABLE.
NOTE:–5 *DISTURBANCE=LOSS OF POWER SUPPLY/LOSS OF CONTROL SUPPLY/ MOTOR THERMOSTAT TRIP/THERMAL OVERLOAD/TORQUE SWITCH OPTD/ LOCAL/OFF/REMOTE SWITCH IN LOCAL/OFF POSITION

BHEL	3X800 MW NTPC PATRATU STPP PHASE–I	DRG.NO.	9585–001–405–PVI–B–152B
	DDCMIS INTERFACE WITH BIDI	SHT	07 OF 34

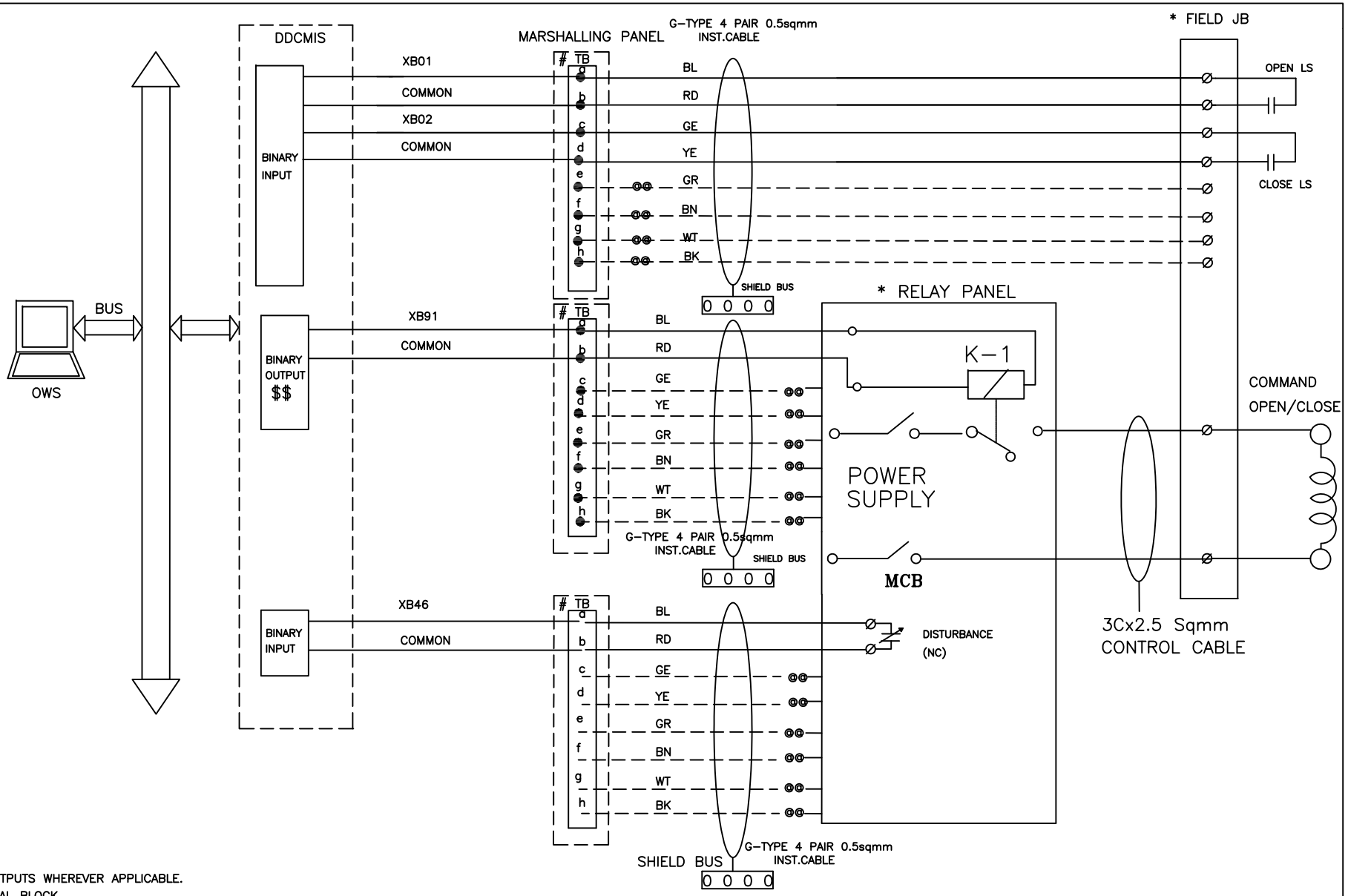
DDCMIS INTERFACE WITH DUAL COIL SOLENOID (DSOV/L)



NOTE:-1 $$ REDUNDANT OUTPUTS WHEREVER APPLICABLE.
NOTE:-2 # 8 LEVEL TERMINAL BLOCK.
NOTE:-3 @@ INEACH DDCMIS POST,UNUSED TB'S ARE USED FOR SPARE CORE TERMINATION.
NOTE:-4 * FEEDBACKS/COMMANDS OF DSOV/SOV CAN BE GROUPED IN FIELD JB/RELAY PANEL AND MULTIPAIR/ MULTICORE CABLE IS TO BE USED FOR GROUPED SIGNALS FROM FIELD JB/RELAYPANEL TO MARSHALING PANEL.
NOTE:-5 FOR ON/OFF TYPE,SOLENOID ACTUATED CONTROL VALVE.
NOTE:-6 TWO INDEPENDENT OUTPUT FROM CONTROL SYSTEM SHALL BE PROVIDED TO PUSH-PULL TYPE VALVES,WITH DUAL COIL SOLENOIDS.

BHEL	3X800 MW NTPC PATRATU STPP PHASE-I	DRG.NO.	9585-001-405-PVI-B-152B
	DDCMIS INTERFACE WITH DUAL COIL SOLENOID (DSOV/L)	SHT	10 OF 34

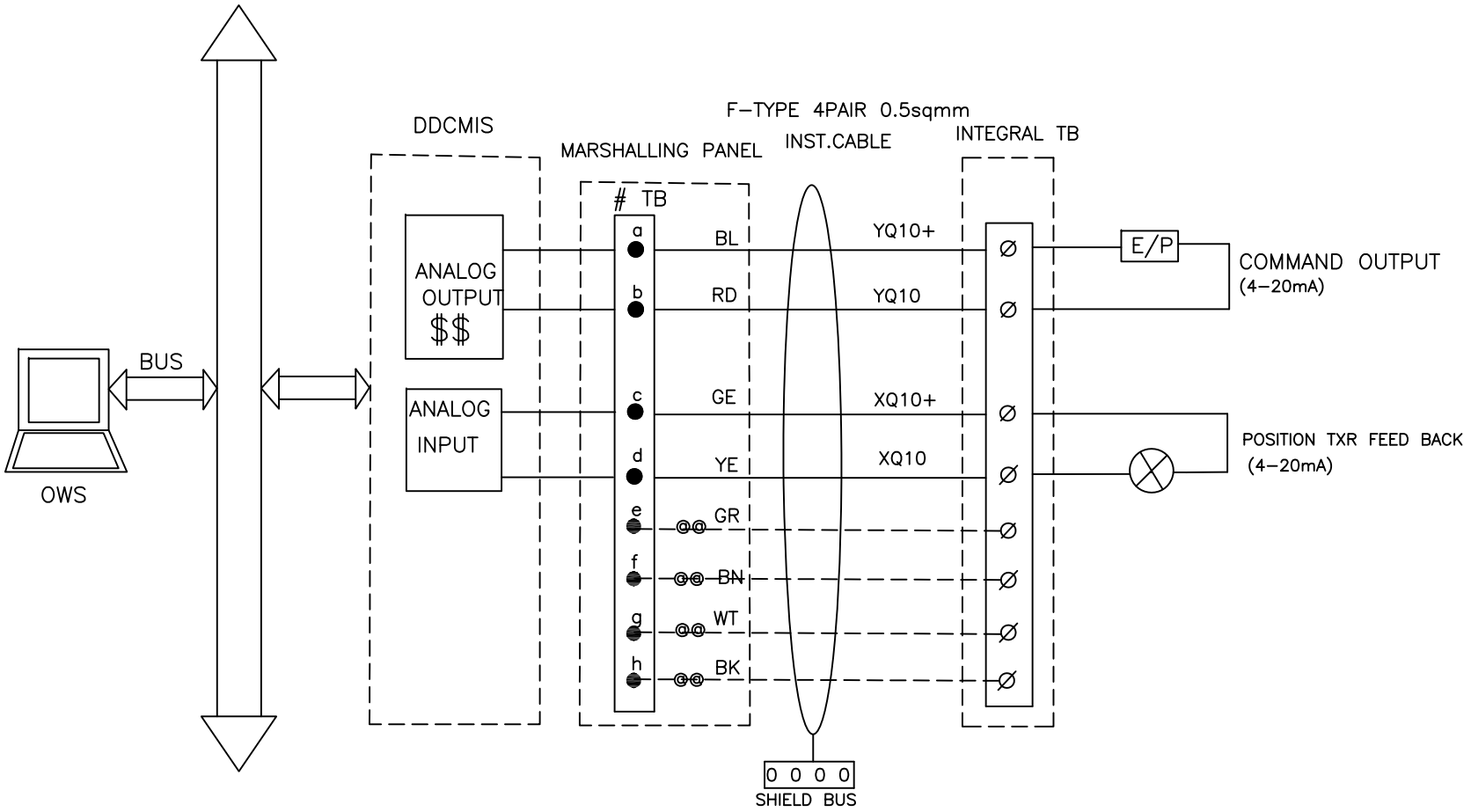
DDCMIS INTERFACE WITH SOV/O/L(WITH FEED BACKS)



NOTE:-1 $$ REDUNDANT OUTPUTS WHEREVER APPLICABLE.
NOTE:-2 # 8 LEVEL TERMINAL BLOCK.
NOTE:-3 @@ INEACH DDCMIS POST,UNUSED TB'S ARE USED FOR SPARE CORE TERMINATION.
NOTE:-4 * FEEDBACKS/COMMANDS OF DSOV/SOV CAN BE GROUPED IN FIELD JB/RELAY PANEL AND MULTIPAIR/ MULTICORE CABLE IS TO BE USED FOR GROUPED SIGNALS FROM FIELD JB/RELAYPANEL TO MARSHALING PANEL.
NOTE:-5 FOR ON/OFF TYPE,SOLENOID ACTUATED CONTROL VALVE.

BHEL	3X800 MW NTPC PATRATU STPP PHASE-I	DRG.NO.	9585-001-405-PVI-B-152B
	DDCMIS INTERFACE WITH SOV/O/L(WITH FEEDBACKS)	SHT	12 OF 34

INTERFACE FOR MODULATING DRIVES – CLCS



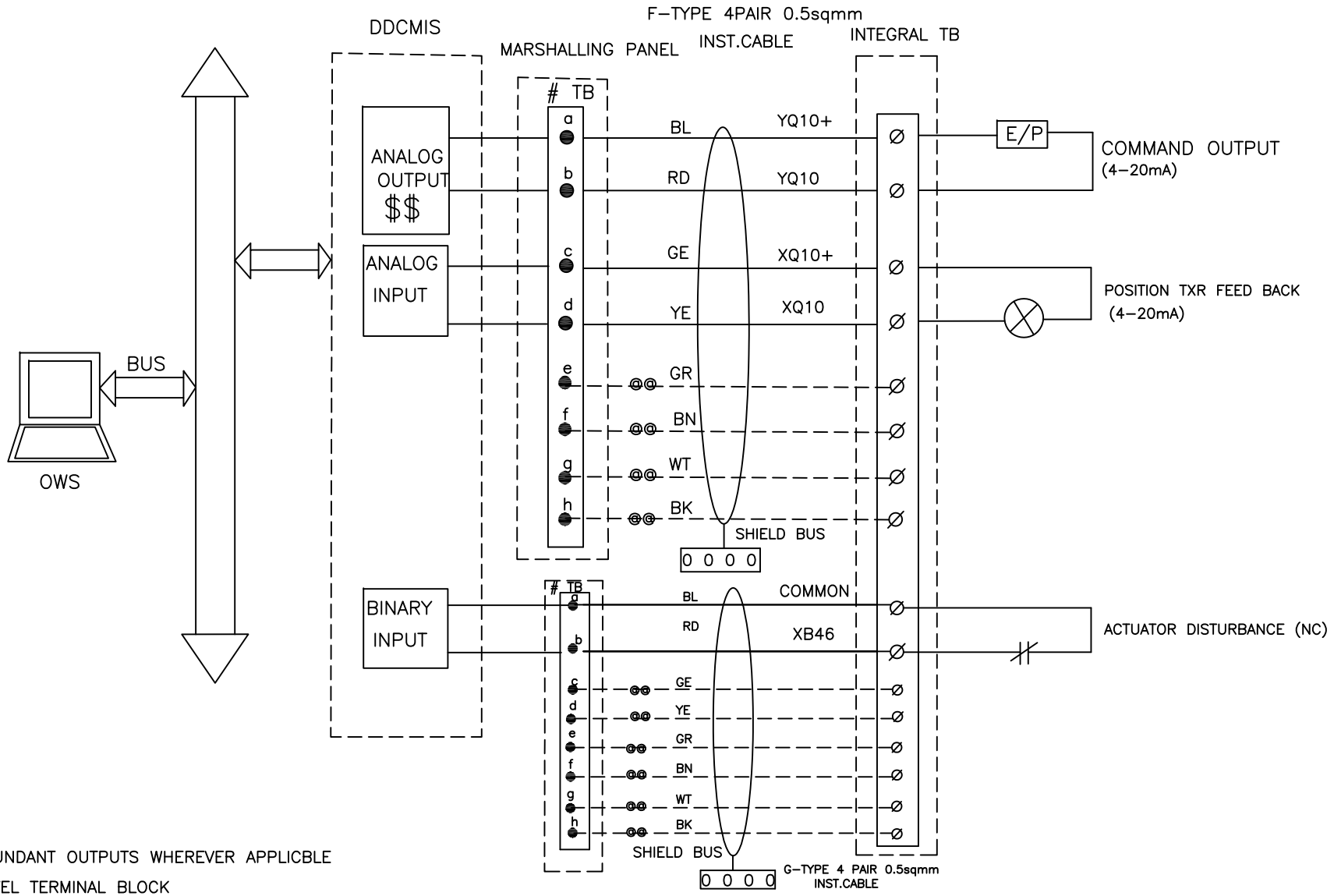
NOTE:–1 $$ REDUNDANT OUTPUTS WHEREVER APPLICBLE
NOTE:–2 # 8 LEVEL TERMINAL BLOCK

NOTE:–3 @@ IN EACH DDCMIS POST, UNUSED TB's ARE USED FOR SPARE CORE TERMINATION.

NOTE:–4 F–TYPE: INDIVIDUAL & OVERALL SHIELD CABLE.

BHEL	3X800 MW NTPC PATRATU STPP PHASE–I	DRG.NO.	9585–001–405–PVI–B–152B
	INTERFACE FOR MODULATING DRIVES – CLCS	SHT	14 OF 34

INTERFACE FOR MODULATING DRIVES – CLCS–M



NOTE:–1 $$ REDUNDANT OUTPUTS WHEREVER APPLICBLE

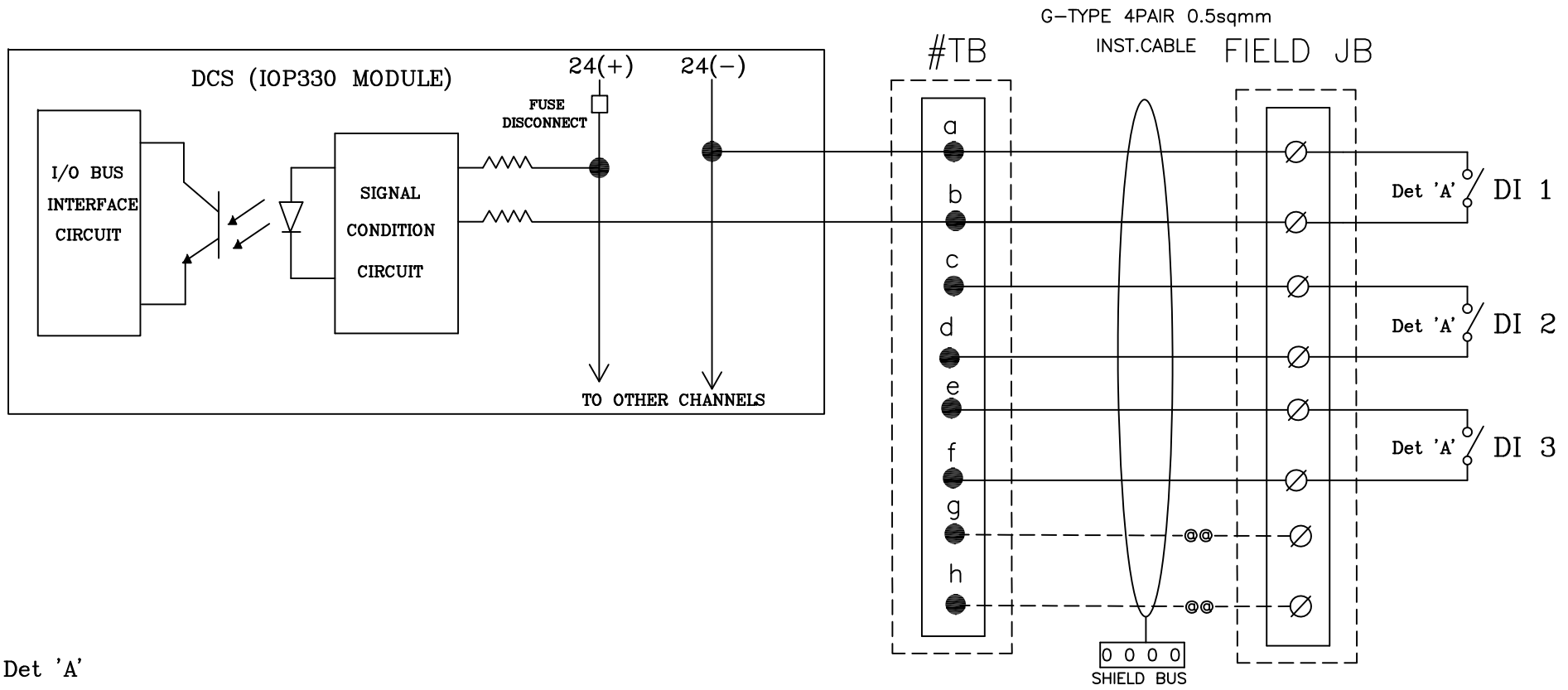
NOTE:–2 # 8 LEVEL TERMINAL BLOCK

NOTE:–3 @@ IN EACH DDCMIS POST, UNUSED TB's ARE USED FOR SPARE CORE TERMINATION.

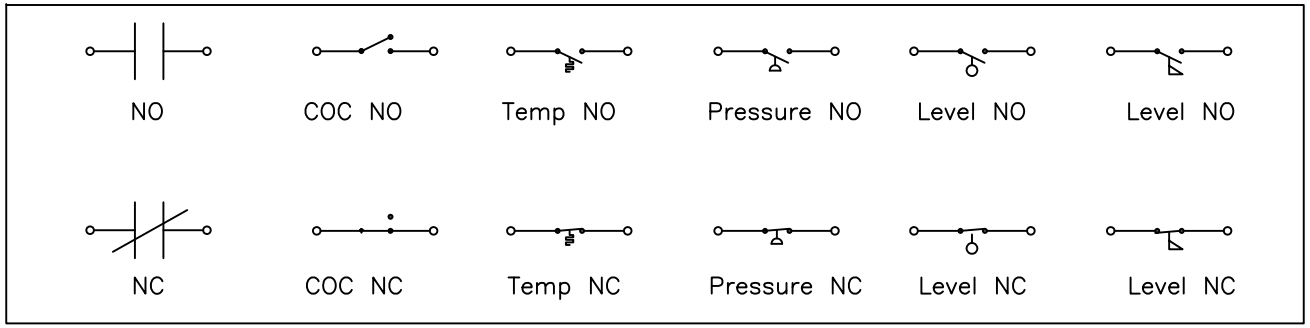
NOTE:–4 F–TYPE: INDIVIDUAL & OVERALL SHIELD CABLE.

BHEL	3X800 MW NTPC PATRATU STPP PHASE–I	DRG.NO.	9585–001–405–PVI–B–152B
	INTERFACE FOR MODULATING DRIVES – CLCS–M	SHT	15 OF 34

DDCMIS INTERFACE WITH DIGITAL INPUT SIGNAL



Det 'A'

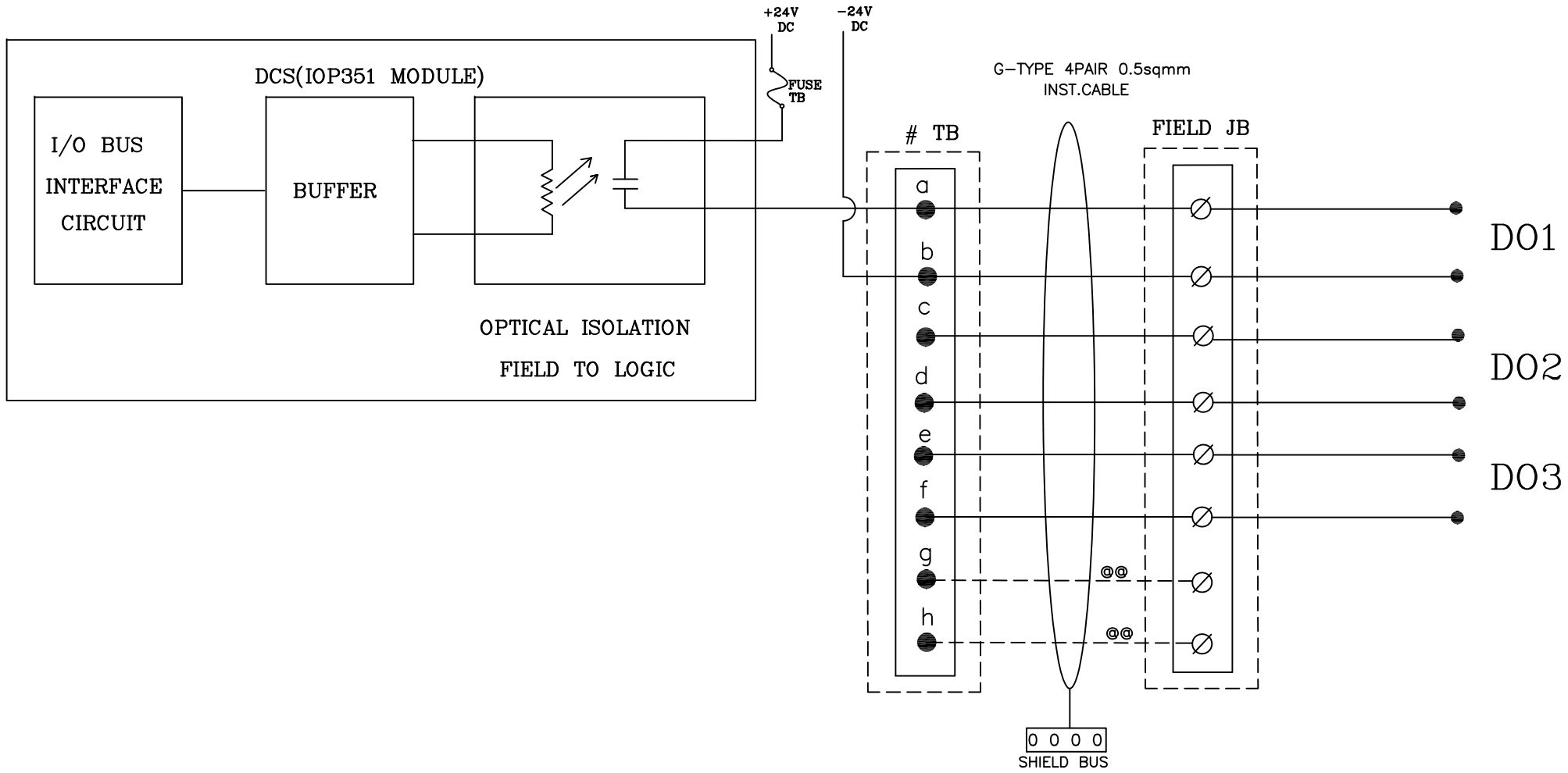


NOTE:–1 #8 LEVEL TERMINAL BLOCK.

NOTE:–2 @@ IN EACH DDCMIS POST, UNUSED TB's ARE USED FOR SPARE CORE TERMINATION.

BHEL	PROJECT: 3X800 MW PATRATU STPP STAGE–I	DRG.NO.	9585–001–405–PVI–B–152B
		DATE	19.09.2018
	DDCMIS INTERFACE WITH DIGITAL INPUT SIGNAL	REV.NO.	03
		SHT	23 OF 34

DDCMIS INTERFACE WITH DIGITAL OUTPUT SIGNAL

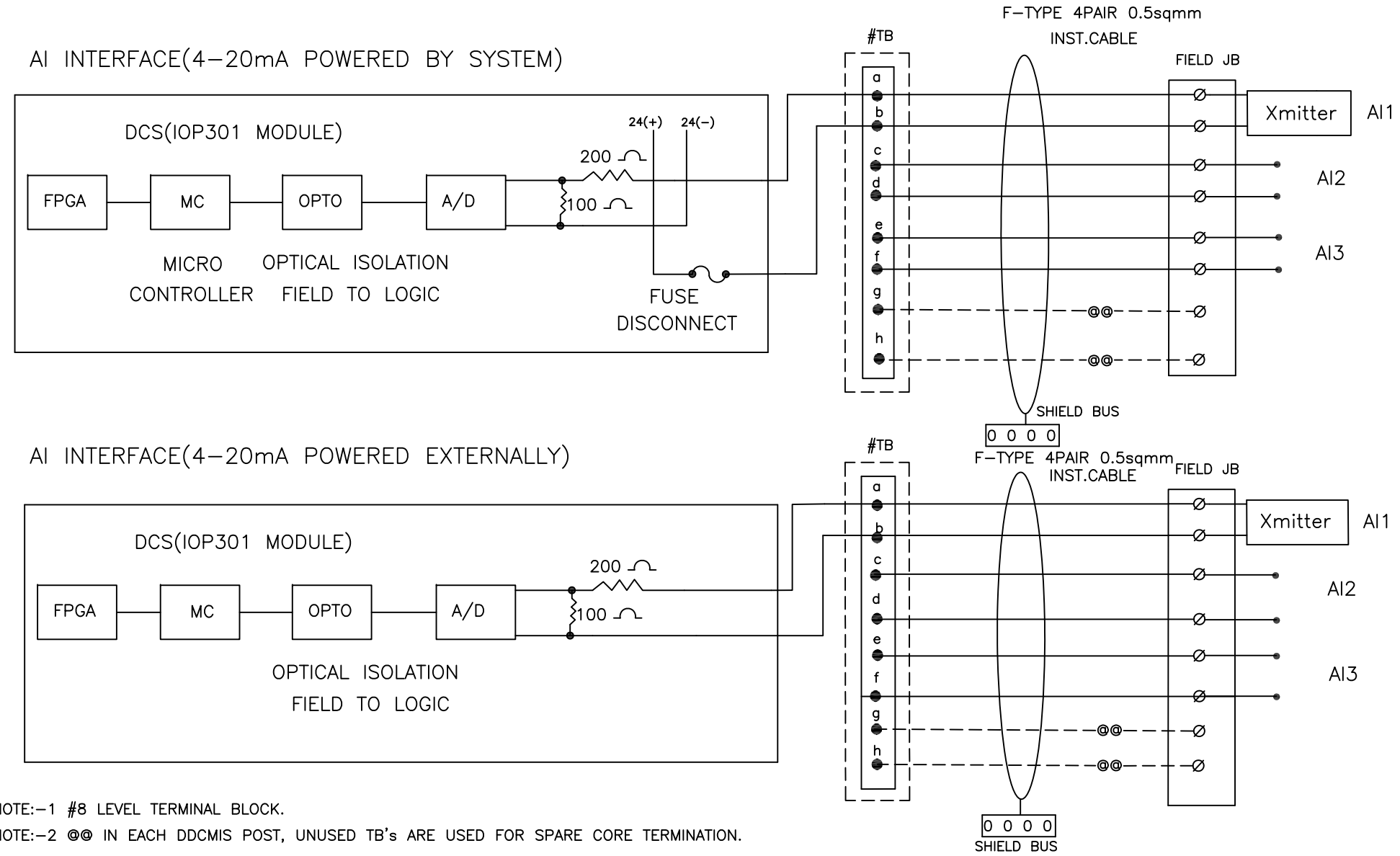


NOTE:-1 #8 LEVEL TERMINAL BLOCK.

NOTE:-2 @@ IN EACH DDCMIS POST, UNUSED TB's ARE USED FOR SPARE CORE TERMINATION.

BHEL	PROJECT: 3X800 MW PATRATU STPP STAGE-I	DRG.NO.	9585-001-405-PVI-B-152B
		DATE	19.09.2018
	DDCMIS INTERFACE WITH DIGTAL OUTPUT SIGNAL	REV.NO.	03
		SHT	24 OF 34

DDCMIS INTERFACE WITH ANALOG INPUT SIGNAL



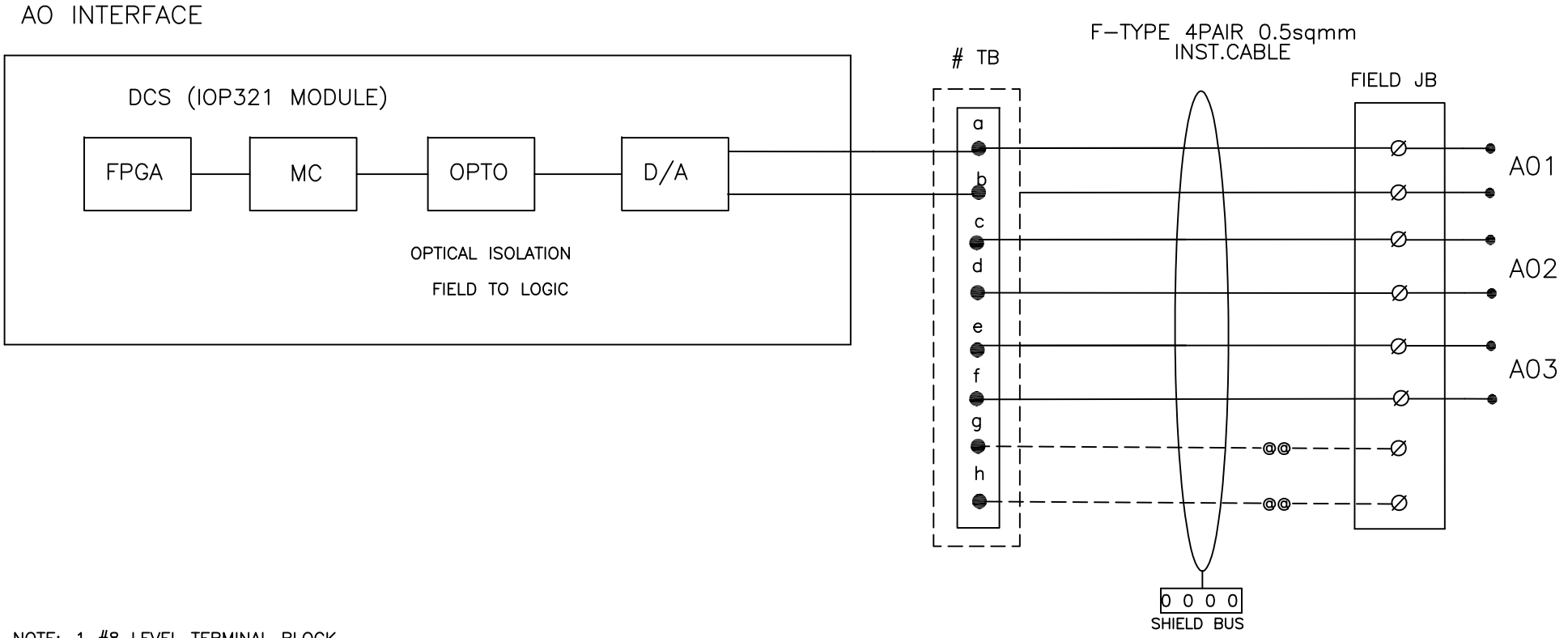
NOTE:–1 #8 LEVEL TERMINAL BLOCK.

NOTE:–2 @@ IN EACH DDCMIS POST, UNUSED TB's ARE USED FOR SPARE CORE TERMINATION.

NOTE:–3 F–TYPE: INDIVIDUAL & OVERALL SHIELD CABLE.

BHEL	PROJECT: 2X800 MW PATRATU STPP STAGE–I	DRG.NO.	9585–001–405–PVI–B–152B
		DATE	19.09.2018
	DDCMIS INTERFACE WITH ANALOG INPUT SIGNAL	REV.NO.	03
		SHT	25 OF 34

DDCMIS INTERFACE WITH ANALOG OUTPUT SIGNAL



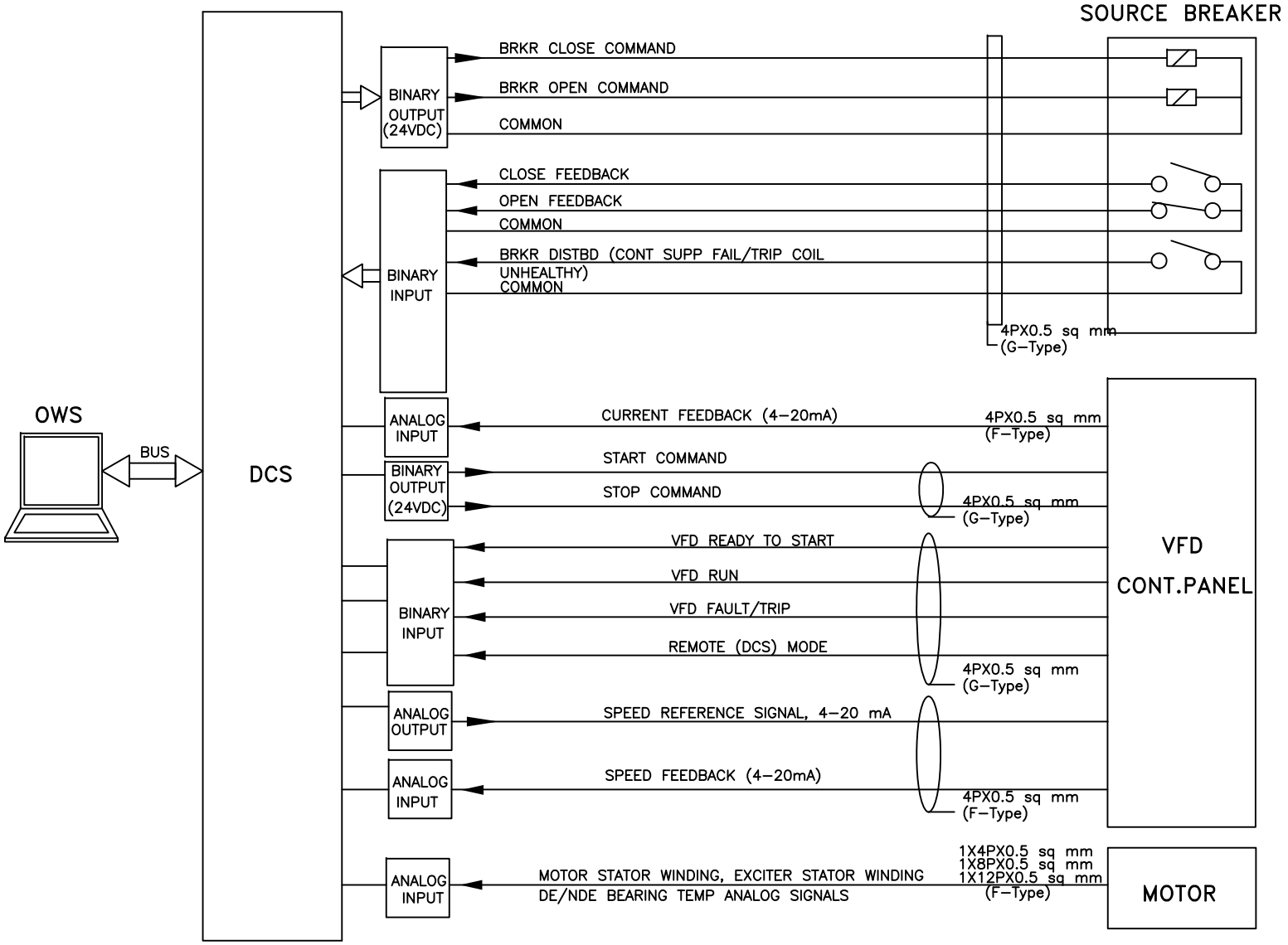
NOTE:-1 #8 LEVEL TERMINAL BLOCK.

NOTE:-2 @@ IN EACH DDCMIS POST, UNUSED TB's ARE USED FOR SPARE CORE TERMINATION.

NOTE:-3 F-TYPE: INDIVIDUAL & OVERALL SHIELD CABLE.

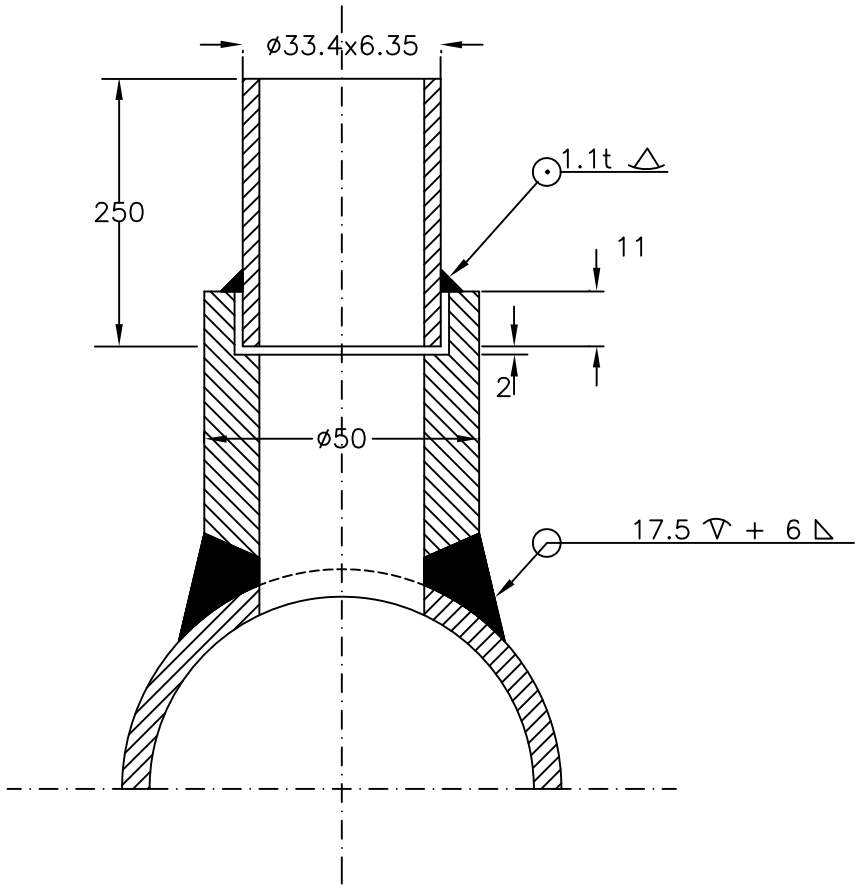
BHEL	PROJECT: 3X800 MW PATRATU STPP STAGE-I	DRG.NO.	9585-001-405-PVI-B-152B
		DATE	19.09.2018
	DDCMIS INTERFACE WITH ANALOG OUTPUT SIGNAL	REV.NO.	03
		SHT	26 OF 34

DCS INTERFACE FOR VFD CONTROL DRIVE



BHEL	PROJECT: 3X800 MW PATRATU STPP	DRG.NO.	9585-001-405-PVI-B-152B
		DATE	01.12.2018
	DDCMIS INTERFACE FOR CEP VFD	REV.NO.	04
		SHT	34b

INSTRUMENT STUB DETAILS



NOTE :

1. MATERIAL OF THE BOSS AND NIPPLE SHALL BE THE SAME AS THE PIPE INTO WHICH IT IS WELDED AND CONFORM TO ANSI B16.11.
2. THE LENGTH OF NIPPLE SHALL BE 250 MM.
3. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE INDICATED
4. EDGE HOLE MUST BE CLEAN AND SQUARE OR ROUNDED SLIGHTLY (1/64" RADIUS) FREE FROM BURRS, WIRE EDGES OR OTHER IRREGULARITIES
5. STUB LENGTH SHALL BE 64mm UPTO 250Nb PIPE, 45mm ABOVE 200Nb PIPE SIZE.

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TITLE :

INSTRUMENT STUB DETAILS FOR PRESSURE MEASUREMENT

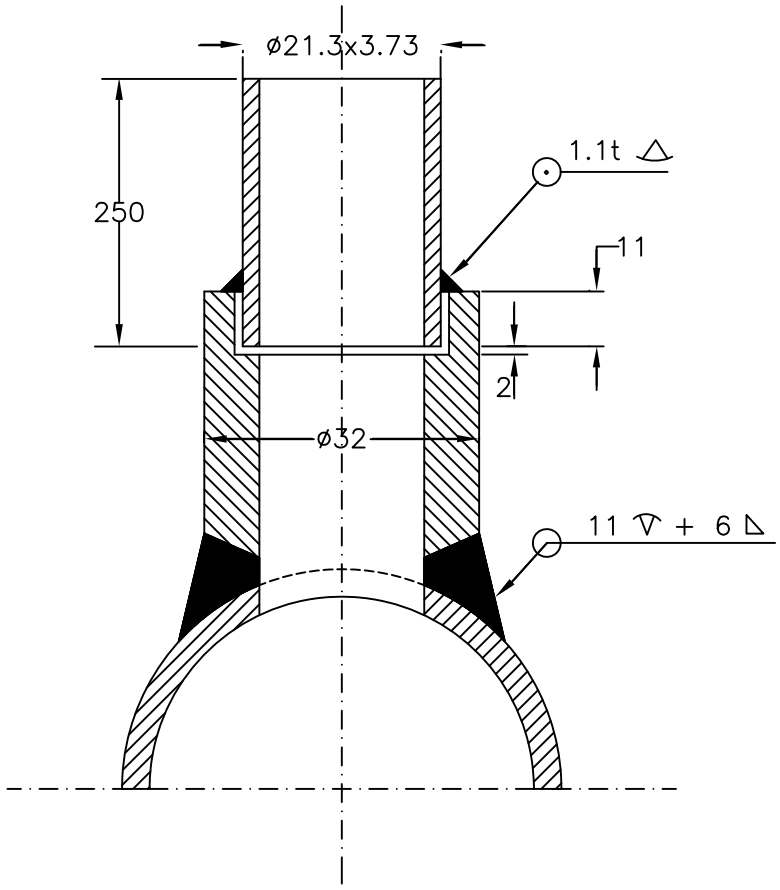
(APPLICABLE FOR TEMP< 500 DegC, CLASS 6000#)

DRG. NO.

PE-DG-434-145-I101

REV. 00

SH. 03 OF 08 SHS.



NOTE :

1. MATERIAL OF THE BOSS AND NIPPLE SHALL BE THE SAME AS THE PIPE INTO WHICH IT IS WELDED AND CONFORM TO ANSI B16.11.
2. THE LENGTH OF NIPPLE SHALL BE 250 MM.
3. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE INDICATED
4. EDGE HOLE MUST BE CLEAN AND SQUARE OR ROUNDED SLIGHTLY (1/64" RADIUS) FREE FROM BURRS, WIRE EDGES OR OTHER IRREGULARITIES
5. STUB LENGTH SHALL BE 64mm UPTO 250Nb PIPE, 45mm ABOVE 200Nb PIPE SIZE.

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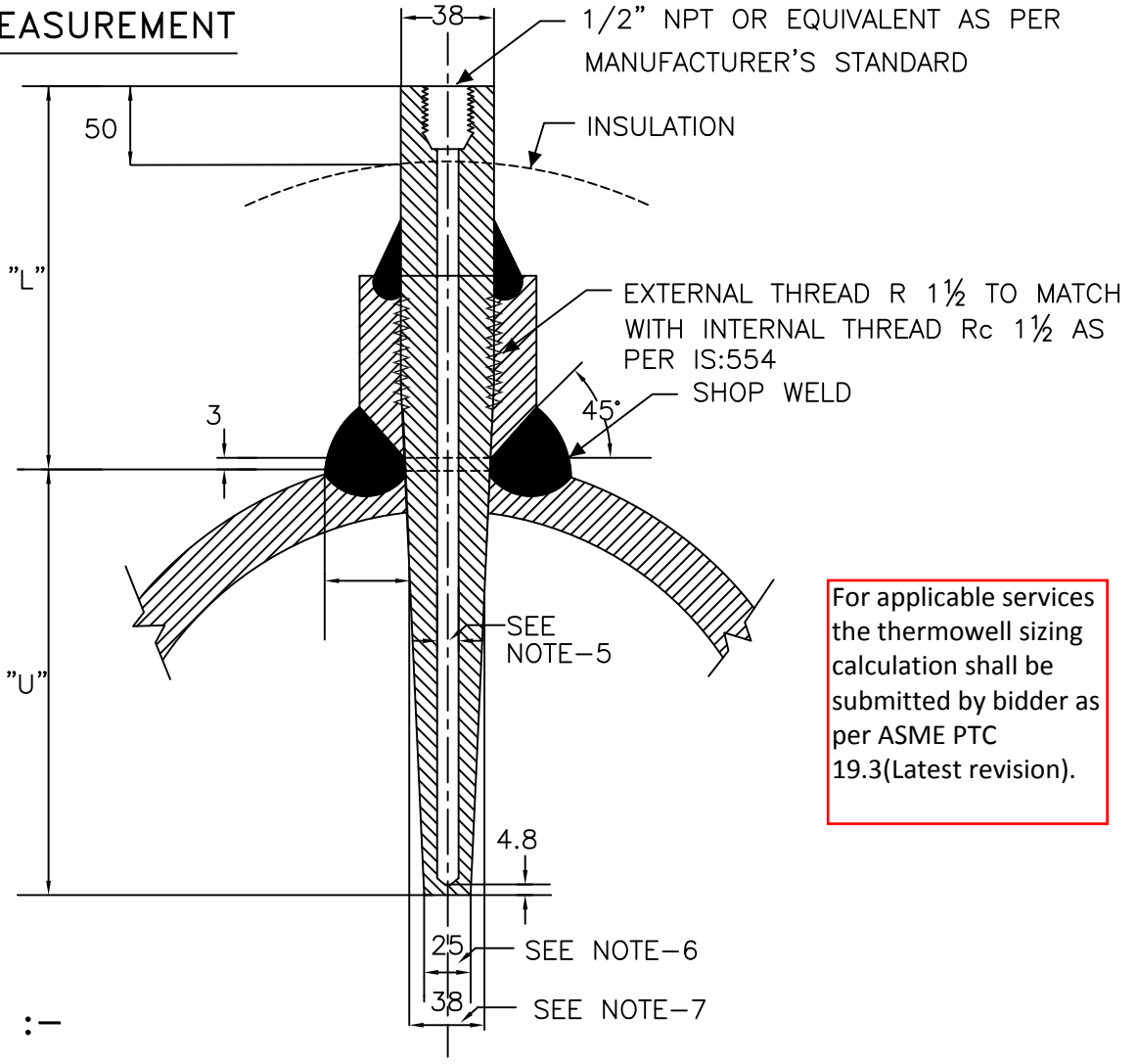
TITLE :

INSTRUMENT STUB DETAILS
FOR PRESSURE MEASUREMENT
(SYSTEM PRESS UPTO 40Kg/Cm2, TEMP< 400 Deg C)

DRG. NO.
PE-DG-434-145-I101
REV. 00
SH. 04 OF 08 SHS.

TEMP. MEASUREMENT



For applicable services the thermowell sizing calculation shall be submitted by bidder as per ASME PTC 19.3(Latest revision).

NOTES :–

1. THIS TYPE OF TEMPERATURE BOSS SHALL BE USED FOR THE PROCESS PRESS EQUAL/ ABOVE 40 KG/CM2(g) AND FOR PROCESS TEMP.>400 DEG C EVEN IF THE PROCESS PRESSURE IS LESS THAN 40 KG/CM2(g).
2. THE MATERIAL OF THE BOSS SHALL BE SIMILAR TO PIPING MATERIAL.
3. MATERIAL OF THE THERMOWELL SHALL BE OF 316SS.
4. THERMOWELL SHALL BE DRILLED BAR STOCK TYPE.
5. INTERNAL BORE OF THE THERMOWELL SHOULD BE SELECTED BASED ON THE NORMAL SIZE OF THE SENSING ELEMENT AS PER ASME PTC–19.3.
6. THE BOTTOM DIAMETER OF THE THERMOWELL TYPICALLY SHOWN HERE SHALL BE SUBJECT TO VARIATION BASED ON THE INTERNAL BORE OF THERMOWELL AND THICKNESS OF THERMOWELL MATERIAL TO WITHSTAND THE PROCESS PRESS AND TEMP AS PER ASME PTC–19.3.
7. THERMOWELL SHALL BE SUITABLE TO MATCH THE STUB DIMENSIONS AS PER Rc 1½.
8. THE 'U' & 'L' DIMENSIONS SHALL BE SELECTED BASED ON PARTICULAR APPLICATION.
9. ORIENTATION OF STUB ON VERTICAL/ HORIZONTAL PIPES SHALL BE 90° TO THE CENTRE LINE OF THE PIPES, FOR PIPE SIZE LARGER THAN 4". HEIGHT OF STUB SHALL BE 64mm FOR PIPE OD < 200Nb AND 45mm FOR PIPE OD ≤ 200Nb.
10. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE INDICATED.

TITLE :

INSTRUMENT STUB DETAILS (TEMP)

(APPLICABLE FOR PIPE SIZE ABOVE 4")

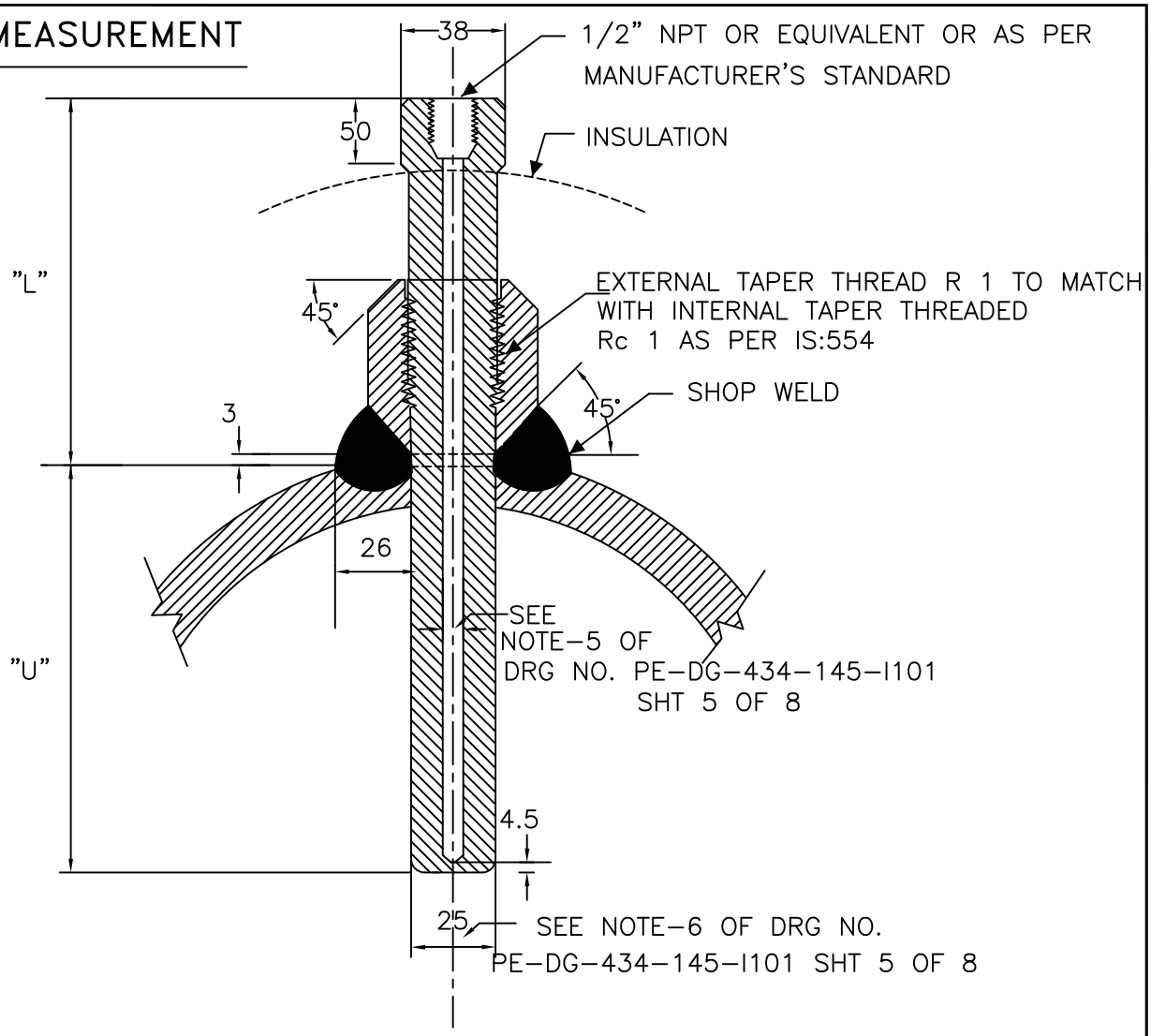
[PROCESS PRESS EQUAL/> 40 Kg/Cm2 (g)
PROCESS PRESS < 40 Kg/Cm2 (g), TEMP.EQUAL/>400 DEG C]

DRG. NO. PE–DG–434–145–I101

REV. 00

SH. 05 OF 08 SHS.

TEMP. MEASUREMENT

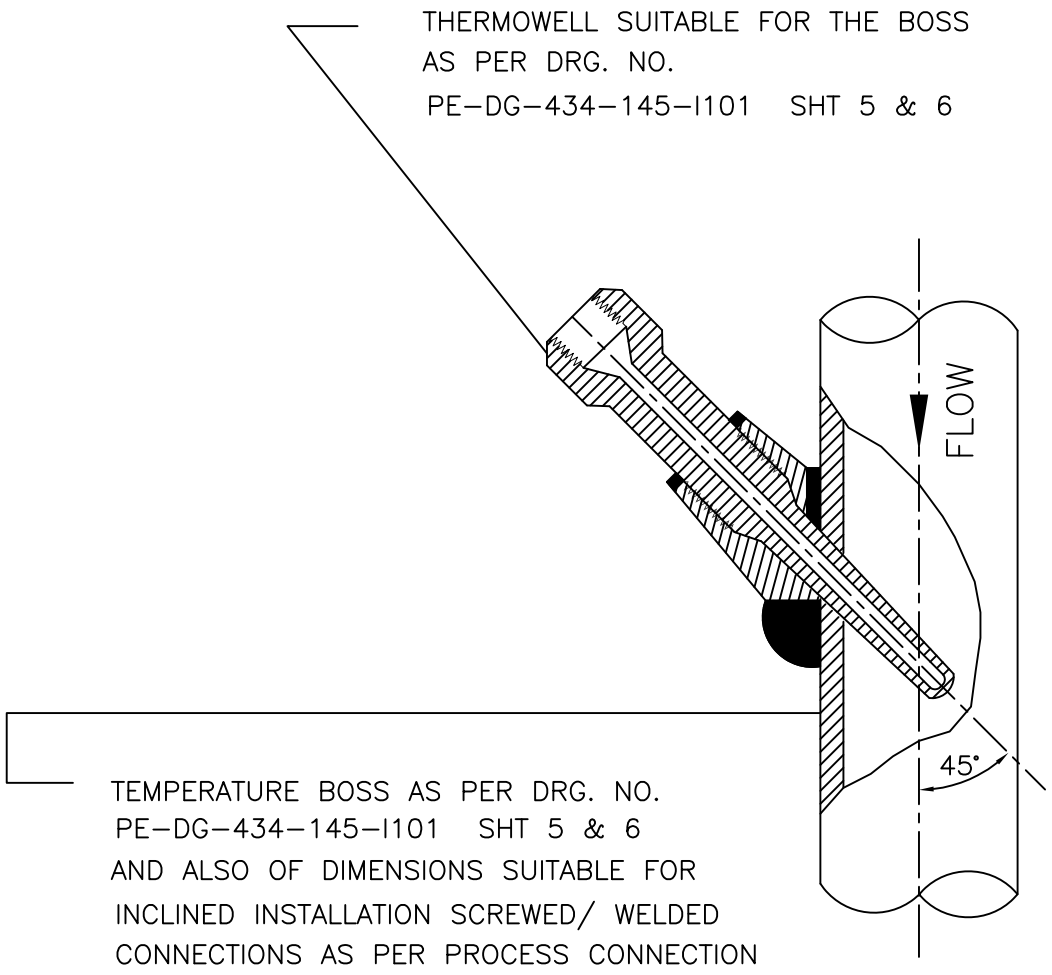


NOTES :-

1. THIS TYPE OF TEMPERATURE BOSS IS APPLICABLE FOR THE PROCESS PRESS/ TEMP. BELOW 40 KG/CM2(g)/400°C.
2. SEE NOTES-2 TO 9 IN SHT. 5 OF 8 OF THIS DRG.
3. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE INDICATED.

For applicable services the thermowell sizing calculation shall be submitted by bidder as per ASME PTC 19.3(Latest revision).

BHEL	TITLE : INST. STUB DETAILS (TEMP) (APPLICABLE FOR PIPE SIZE ABOVE 4") [PROCESS PRESS < 40 Kg/Cm2 (g),TEMP < 400 ℃]	DRG. NO. PE-DG-434-145-I101 REV. 00 SH. 06 OF 08 SHS.



NOTES :–

1. INCLINED INSTALLATION OF THERMOWELL SHALL BE APPLICABLE FOR 4" AND SMALLER LINE SIZE BUT LIMITED TO MIN. 3" LINE SIZE.
2. FOR 2" AND SMALLER LINE SIZE NECESSARY EXPANDER OF 3" SIZE OF MAIN PIPING SPECIFICATION SHALL BE USED.
3. THIS TYPE OF INSTALLATION IS APPLICABLE FOR HORIZONTAL AND VERTICAL PIPE SECTION.
4. FOR STEAM SERVICES EXPANDER SECTION MAY BE USED ONLY IN VERTICAL RUN.
5. THE EXPANDER SECTION SHALL BE OF ADEQUATE LENGTH (ATLEAST 3–4 TIMES DIA OF THE MAIN PROCESS PIPE AT BOTH SIDE OF INSTALLED THERMOWELL).

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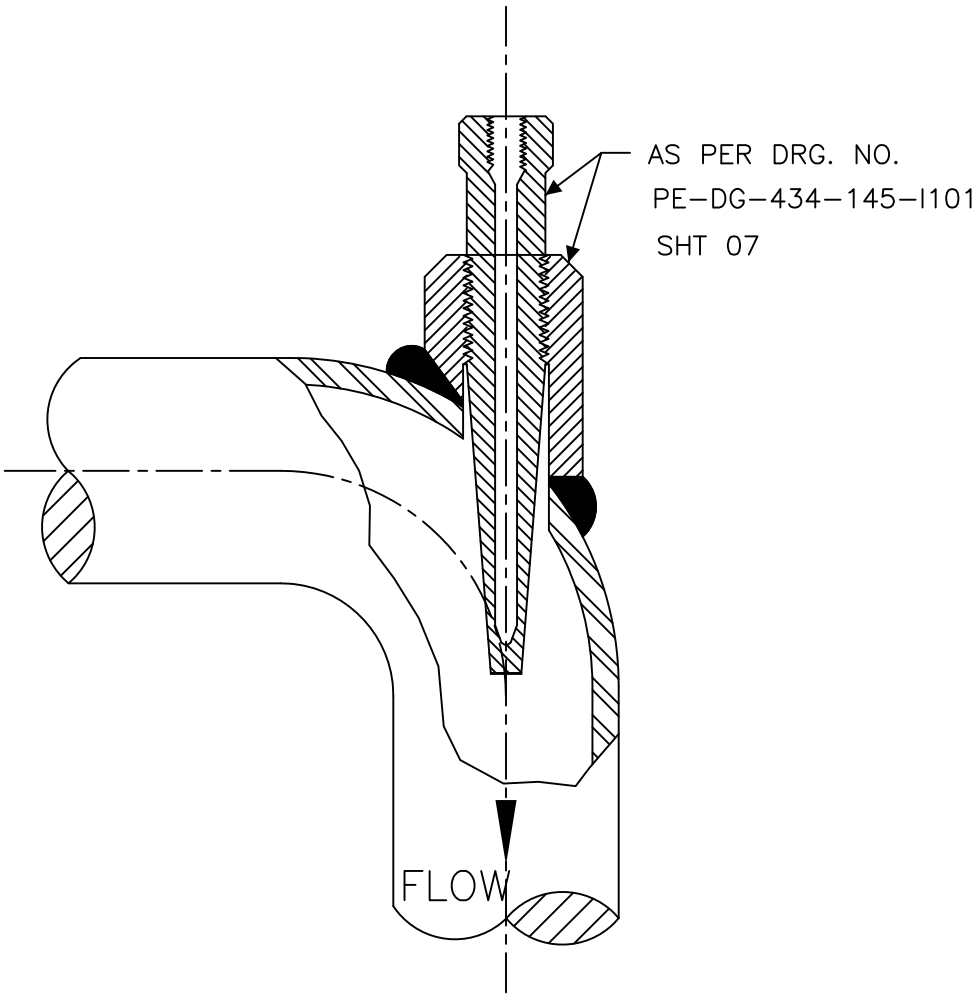
TITLE :

THERMOWELL INSTALLATION

DRG. NO.
PE–DG–434–145–I101
REV. 00
SH. 07 OF 08 SHS.



NOTES :–

1. FLOW INSTALLATION OF THERMOWELL SHALL BE APPLICABLE FOR 4" AND SMALLER LINE SIZE BUT LIMITED TO MINIMUM 3" LINE SIZE. THIS DETAIL IS APPLICABLE FOR THERMOWELL INSTALLATION IN BEND PIPES.
2. FOR 2" AND SMALLER LINE SIZE NECESSARY EXPANDER OF ELBOW FORM (AS SHOWN) OF 3" SIZE SHALL BE USED.
3. ELBOW EXPANDER SECTION IN HORIZONTAL PLANE TO BE USED FOR LIQUID SERVICE. FOR STEAM SERVICES EXPANDER SECTION TO BE USED IN VERTICAL PLANE.

TITLE :

THERMOWELL INSTALLATION (IN BEND PIPES)

DRG. NO.
PE–DG–434–145–I101
REV. 00
SH. 08 OF 08 SHS.

QUALITY ASSURANCE FOR INSTRUMENTS

1.00.00 TYPE TEST REQUIREMENTS

1.01.00 General Requirements

1.01.01 The Contractor shall furnish the type test reports of all type tests as per relevant standards and codes as well as other specific tests indicated in this specification. If the bidder proposes a different standard/code from that indicated at table 3.00.00, same is acceptable provided the equivalence of the proposed standard is established by the bidder. A list of such tests are given for various equipment in table titled 'TYPE TEST REQUIREMENT FOR C&I SYSTEMS' at the end of this chapter and under the item Special Requirement for Solid State Equipments/Systems. For the balance equipment instrument, type tests may be conducted as per manufactures standard or if required by relevant standard.

(a) Out of the tests listed, the Bidder/ sub-vendor/ manufacturer is required to conduct certain type tests specifically for this contract (and witnessed by Employer or his authorized representative) even if the same had been conducted earlier, as clearly indicated subsequently against such tests.

(b) For the rest, submission of type test results and certificate shall be acceptable provided.

i. The same has been carried out by the Bidder/ sub-vendor on exactly the same model /rating of equipment.

ii. There has been no change in the components from the offered equipment & tested equipment.

iii. The test has been carried out as per the latest standards alongwith amendments as on the date of Bid opening.

(c) In case the approved equipment is different from the one on which the type test had been conducted earlier or any of the above grounds, then the tests have to be repeated and the cost of such tests shall be borne by the Bidder/ sub-vendor within the quoted price and no extra cost will be payable by the Employer on this account.

1.01.02 As mentioned against certain items, the test certificates for some of the items shall be reviewed and approved by the main Bidder or his authorized representative and the balance have to be approved by the Employer.

1.01.03 The schedule of conduction of type tests/ submission of reports shall be submitted and finalized during pre-award discussion.

1.01.04 For the type tests to be conducted, Contractor shall submit detailed test procedure for approval by Employer. This shall clearly specify test setup, instruments to be used, procedure, acceptance norms (wherever applicable), recording of different parameters, interval of recording precautions to be taken etc. for the tests to be carried out.

1.01.05 The Bidder shall indicate in the relevant BPS schedule, the cost of the type test for each item only for which type tests are to be conducted specifically for this project. The cost shall only be payable after conduction of the respective type test in presence of authorize representative of Employer. If a test is waived off, then the cost shall not be payable.

2.00.00 **SPECIAL REQUIREMENT FOR SOLID STATE EQUIPMENTS/ SYSTEMS**

2.01.00 The minimum type test reports, over and above the requirements of above clause, which are to be submitted for each of the major C&I systems shall be as indicated below:

i) Surge Withstand Capability (SWC) for Solid State Equipments/ Systems

All solid state systems/ equipments shall be able to withstand the electrical noise and surges as encountered in actual service conditions and inherent in a power plant. All the solid state systems/ equipments shall be provided with all required protections that needs the surge withstand capability as defined in ANSI 37.90.1/ IEEE-472. Hence, all front end cards which receive external signals like Analog input & output modules, Binary input & output modules etc. including power supply, data highway, data links shall be provided with protections that meets the surge withstand capability as defined in ANSI 37.90.1/ IEEE-472. Complete details of the features incorporated in electronics systems to meet this requirement, the relevant tests carried out, the test certificates etc. shall be submitted along with the proposal. As an alternative to above, suitable class of EN 61000-4-12 which is equivalent to ANSI 37.90.1/ IEEE-472 may also be adopted for SWC test.

ii) Dry Heat test as per IEC-68-2-2 or equivalent.

iii) Damp Heat test as per IEC-68-2-3 or equivalent.

iv) Vibration test as per IEC-68-2-6 or equivalent.

v) Electrostatic discharge tests as per EN 61000-4-2 or equivalent.

vi) Radio frequency immunity test as per EN 61000-4-6 or equivalent.

vii) Electromagnetic Field immunity as per EN 61000-4-3 or equivalent.

Test listed at item no. v, vi, vii, above are applicable for electronic cards only as defined under item (i) above.

3.00.00 **TYPE TEST REQUIREMENT FOR C&I SYSTEMS**

Sl. No	Item	Test Requirement	Standard	Test To Be Specifically Conducted	NTPC's Approval Req. On Test Certificate
Col 1	Col 2	Col 3	Col 4	Col 5	Col 6
1	Elect. Metering instruments	As per standard (col 4)	IS-1248	No	Yes
2	Transducers	As per standard (col 4)	IEC-60688,IS12784	No	Yes
3	Thermocouple	Degree of protection test	IS-13947	No	No
4	RTD	As per standard (col 4)	IEC-60751	No	No
5	Electronic transmitter	As per standard (col 4)	BS-6447 / IEC-60770	No	Yes
6	E/P converter	As per standard (col 4)	Mfr. standard	No	No
~~7~~	~~Dust emission monitor~~	~~Degree of protection test~~	~~IS-13947~~	~~No~~	~~Yes~~
8	Instrumentation Cables Twisted & Shielded*				
	-Conductor	Resistance test	VDE-0815	No	Yes
		Diameter test	IS-10810	No	Yes
		Tin Coating test (Persul-phate test)	IS-8130	No	Yes
	-Insulation	Loss of mass	VDE 0472	No	Yes
		Ageing in air ovens**	VDE 0472	No	Yes

		Tensile strength and elongation test before and after ageing**	VDE 0472	No	Yes
		Heat shock	VDE 0472	No	Yes
		Hot deformation	VDE 0472	No	Yes
		Shrinkage	VDE 0472	No	Yes
		Bleeding & blooming	IS-10810	No	Yes
	-Inner sheath***	Loss of mass	VDE 0472	No	Yes
		Heat shock	VDE 0472	No	Yes
		Cold bend/ cold impact test	VDE 0472	No	Yes
		Hot deformation	VDE 0472	No	Yes
		Shrinkage	VDE 0472	No	Yes
	-Outer sheath	Loss of mass	VDE 0472	No	Yes
		Ageing in air ovens**	VDE 0472	No	Yes
		Tensile strength and elongation test before and after ageing**	VDE 0472	No	Yes
		Heat shock	VDE 0472	No	Yes
		Hot deformation	VDE 0472	No	Yes
		Shrinkage	VDE 0472	No	Yes
		Bleeding & blooming	IS-10810	No	Yes
		Colour fastness to water	IS-5831	No	Yes

		Cold bend/ cold impact test	VDE-0472	No	Yes
		Oxygen index test	ASTMD-2863	No	Yes
		Smoke Density Test	ASTMD-2843	No	Yes
		Acid gas generation test	IEC-60754-1	No	Yes
	-fillers	Oxygen index test	ASTMD-2863	No	Yes
		Acid gas generation test	IEC-60754-1	No	Yes
	-AL-MYLAR shield	Continuity test		No	Yes
		Shield thickness		No	Yes
		Overlap test		No	Yes
	-Over all cable	Flammability Test	IEEE 383	No	Yes
		Swedish Chimney Test	SEN 4241475	No	Yes
		Noise interference	IEEE Trans-actions	No	Yes
		Dimensional checks	IS 10810	No	Yes
		Cross talk	VDE-0472	No	Yes
		Mutual capacitance	VDE-0472	No	Yes
		HV test	VDE-0815	No	Yes
		Drain wire continuity		No	Yes

* 1.0 All cables to be supplied shall be of type tested quality. The Contractor shall submit for Owner's approval the reports of all the type tests as listed in this specification and carried out within last Ten years from the date of bid opening. These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.

2.0 In case the Contractor is not able to submit report of the type test(s) conducted within last Ten years from the date of bid opening, or in case the type test report(s) are not found to be meeting the specification requirements, the Contractor shall conduct all such tests either in an independent laboratory or at manufacturer's works in presence of Owner's representative under this contract free of cost to the Owner and submit the reports for approval.

**These tests shall be carried out as per VDE0207 Part 6 & ASTMD-2116 for TEFLON insulated & outer sheathed cables

***Applicable for armoured cables only

9 DC Power Supply System (Applicable for each model and rating)

1)The Type Test reports for offered rectifier module and the controller module irrespective of the rectifier bank shall be acceptable

Surge Withstand Capability(SWC)	ANSI 37.90.1/ IEEE-472,EN 61000-4-12	No	Yes
Dry Heat Test	IEC-68-2-2 or equivalent	No	Yes
Damp Heat test	IEC-68-2-3 or equivalent	No	Yes
Vibration test	IEC68-2-6 or equivalent	No	Yes
Electrostatic discharge test	EN 61000-4-2 orr equivalent	No	Yes
Radio frequency immunity test	EN-61000-4-3 orr equivalent	No	Yes
Electromagnetic field immunity	EN 61000-4-3 orr equivalent	No	Yes
Degree of Protection	IS-13947 or equivalent	No	Yes

13	Voltage Stabilisers	Over Load Test	Approved procedure	No	Yes
		Temp rise test without redundant fans	Approved procedure	No	Yes
14	Public Address System				
	- Amplifiers	As per standard (col 4)	IS 9302, Part-II	No	Yes
	Microphones	As per standard (col 4)	IS 9302, Part-III IS 15482:2004/ IEC 61842(2002)	No	Yes
	Loudspeaker	As per standard (col 4)	IS 9302, Part-IV	No	Yes
15	LIE / LIR	Degree of protection test	IS-13947	No	Yes
16	Flue gas analyzers	Degree of protection test	IS-13947	No	Yes
17	Master Clock	Functional test	As per approved procedure	No	Yes
18	CJC Box	Degree Of protection test	IS-13947	No	Yes
19	Junction Box	Degree Of protection Test	IS-13947	No	Yes
20	OPC Data Access Server, Data Exchange Server &	OPC Compliance Testing		No	Yes (Self certification is also

	Historical Data Access Server				acceptable)
21	Conductivity Type Level Switch	Degree of protection test	IS-2147	No	No
22	Local Gauges	Degree of protection test	IS-2147	No	No
23	Process actuated Switches	Degree of protection test	IS-2147	No	No
24	Control Valves	CV test	ISA 75.02& 75.11	No	Yes
25	PLCs	As per standard (Col 4)	IEC 1131	No	No
26	Flow Nozzle Orifice plates	Calibration	ASME PTC BS 1042	No	Yes

The contractor shall submit for Employers approval the reports of all the type test as per latest IS-10918 carried out within last ten years from the date of Bid opening and the test(s) should have been either conducted at an independent laboratory or in presence / owners representative. The complete type test reports shall be for any rating of Battery in a particular group based on plate dimensions being manufactured by supplier.

Note:

Type Tests are to be conducted only for the items, which are being supplied as a part of this Package.

MEASURING INSTRUMENTS (PRIMARY AND SECONDARY)

TESTS / ITEMS	Dimensions (R)	Make, Model, Type, Rating (R)	Process / Electrical connection (R)	Calibration (R)	Test as per standard(R)	Insulation Resistance (R)	IBR Certification (if applicable)(R)	Hydro Test(R)	Material Test certificate ®
1. PR Gauge (IS-3624)	Y	Y	Y	Y	Y				
2. Temp. Gauge (BS-5235)	Y	Y	Y	Y	Y				
3. Pr./D.P.Switch(BS-6134)	Y	Y	Y	Y	Y	Y			
4. Electronic Transmitter(IEC-770)	Y	Y	Y	Y	Y	Y			
5. Temp. Switch	Y	Y	Y	Y	Y	Y			
6. Recorder(IS-9319/ANSI C-39.4)	Y	Y	Y	Y	Y	Y			
7. Vertical indicators	Y	Y	Y	Y		Y			
8. Digital Indicators	Y	Y	Y	Y		Y			
9. Integrators	Y	Y	Y	Y					
10. Electrical Metering Instrument (IS-1248)	Y	Y	Y	Y	Y	Y			
11. Transducer (IEC-688)	Y	Y	Y	Y	Y	Y			
12. Thermocouples (ANSI-MC-96.1)	Y	Y	Y	Y	Y	Y			
13. RTD(IEC-751)	Y	Y	Y	Y	Y	Y			
14. Thermowell	Y		Y				Y	Y	Y

R-Routine Test A- Acceptance Test Y – Test applicable

:

TESTS / ITEMS	Dimensions (R)	Make, Model, Type, Rating (R)	Process / Electrical connection (R)	Calibration (R)	Requirement as per standard (R)	WPS approval (A)	Non-destructive testing (R)	Calculation for accuracy (R)	Insulation Resistance (R)	IBR Certification as applicable (R)	Hydro test (R)	Material test certificate (A)
15. Cold junction compensation box	Y	Y	Y	Y					Y			
16. Orifice plate(BS-1042)	Y	Y	Y	Y *	Y	Y **	Y **			Y	Y **	Y
17. Flow nozzle(BS-1042)	Y	Y	Y	Y *	Y	Y	Y			Y	Y	Y
18. Impact head type element	Y	Y	Y					Y				Y
19. Level transmitter/float type switch	Y	Y	Y	Y					Y	Y	Y	Y
20. Flue Gas analyser	Y	Y	Y	Y								
21. Dust emission monitors	Y	Y	Y	Y								
*Calibration to be carried out on one flow element of each type and size if calibration carried out as type test same shall not be repeated.												
** If applicable												
R-Routine Test A- Acceptance Test Y – Test applicable												

Note: 1) Detailed procedure of Environmental Stress screening test shall be as per Quality Assurance. Programme in General Technical Conditions

2) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted alongwith relevant supporting documents.

CONTROL VALVE ACTUATORS AND ACCESSORIES.

TESTS / ITEMS	Make,model, tag (R)	Dimension®	Surface finish®	Heat Treatment®	Material Test Certificates®	IBR Certificates®	Hydraulic Test®	UT/Radiography for >900 lb rating®	MPI/DP®	Pressure Resistance®	Seat leakage®	Timeing Open/Close®	Linearity/Hysterisis®	Functional Test, review for make and TC of accessories®
CONTROL VALVE AND ACTUATOR														
Overall	Y	Y	Y			Y	Y				Y	Y	Y	Y
Body		Y	Y	Y	Y			Y	Y	Y				
Bonnet		Y	Y	Y	Y									
Trim		Y			Y			Y*						
Pneumatic actuator	Y	Y								Y				
Electro pneumatic positioner	Y													Y

R- Routine Test A - Acceptance Test Y - Test Applicable

Y* - **UT on spindle dia >= 40 mm.**

Note : **1)** Detailed procedure of Environmental Stress Screening test shall be as per Quality Assurance Programme General Technical Conditions

2) This is an indicative list of tests/checks. The manufacture is to furnish a detailed Quality Plan indicating his practice & Procedure along with relevant supporting documents during QP finalisation for all item.

ELECTRICAL ACTUATOR WITH INTEGRAL STARTER

Test/Attributes Characteristics / ITEM/ COPONENT/ SUB SYSTEM ASSEMBLY/ TESTING	RPM ®	No Load Current ®	IR & HV Test®	Mounting Dimension®	All routine Test as per Standard & Specification®	Correct Phase Sequence®	Operation & Setting of limit Switch/Torque Switch®	Stall Torque/Current (A)	Hand Wheel operation/ Auto de clutch function (A)	Function of Aux. like Potentiometer, space heater, position indicator ®	EPT output ®	Grease leakage ®	Local/ Remote (Open-Stop-Close) Operation® Safety check (Single phasing, Phase correction, Tripping etc.) (A)
ELECTRICAL ACTUATOR WITH INTEGRAL STARTER(IS_9334)													
Motor	Y	Y	Y	Y	Y								
Final Testing	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Note: 1) Detailed procedure of Environmental Stress Screening test shall be as per Quality Assurance Programme in General Technical Conditions. Requirement of test and procedure finalized during QP finalization

2) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the practices and procedure adopted along with relevant supporting documents.

® - Routine Test (A) - Acceptance Test Y - Test applicable

1.00.00	**MAINTENANCE AND CALIBRATION EQUIPMENT**
1.01.01	Maintenance and Calibration equipments of proven type, shall be provided as a minimum by the Contractor. The Contractor shall be responsible for supplying all accessories and any necessary additional tools as required for proper maintenance and calibration of the installed C&I devices/systems.
1.01.02	Electrical power supply requirement of the instruments offered under this Sub-section shall be 230 V AC, 50 Hertz nominal, single phase.
1.01.03	All the electronic M&C items shall be microprocessor based and shall have the data logging facility for keeping calibration/maintenance records with proper communication facility for downloading these data on the Lab PC.
1.01.04	The calibration standards of all M&C equipments furnished under this sub-section shall be traceable to National Bureau of Standards, USA or NPL, India or to the applicable standards existing in the country where the equipment is manufactured.
1.01.05	Bidder to note that these maintenance & calibration equipment shall be for Employer's use for normal operation & maintenance of the plant & shall not be used by the bidder for calibration etc during commissioning. During commissioning, for calibration and other activities, Bidder shall bring his own equipment.
1.01.06	The accuracy of the M&C equipments shall be better than the instrument being calibrated. The range of all the M&C equipments shall cover the entire range of the instruments being provided under this contract. Dustproof carrying case and rechargeable battery along with external charger shall be provided with all equipments.
1.01.07	Contractor shall ensure with appropriate documentation that direct service/support from the M&C item supplier/manufacturer shall be available to the employer for all M&C items for a minimum period of 5 years after the expiry of defect liability period.

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR FLOW SWITCH

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	100%	APPROVED SPEC./ DATA SHEETS	P	W	V	
	TYPE						
	RANGE						
	MODEL / TAG No.						
	END CONNECTION						
	DIMENSIONS						
	SIZE						
2	ACCURACY & REPEATABILITY (WET CALIBRATION)	100%		P	W	V	
3	HV / IR	100%		P	W	V	
4	CONTACT RATING / No. OF CONTACTS	RANDOM		P	W	V	
5	MATERIAL TC FOR BODY, WET PARTS, SENSING ELEMENT	ONE / LOT		P	W	V	
6	ACCESSORIES AS APPLICABLE	100%		P	W	V	
7	DEGREE OF PROTECTION	ONE / LOT		P	W	V	
8	OVER PRESSURE TEST	100%		P	W	V	

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Manufacturer to carry out routine test for 100%
4. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR ANALYTICAL INSTRUMENTS

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	V	V	
	VISUAL						
	MAKE, MODEL No.						
	POWER SUPPLY						
	TYPE						
2	DIMENSIONS CHECK			P	V	V	
3	FUNCTIONAL CHECK			P	V	V	
4	LEAKAGE TEST			P	V	V	
5	HV / IR TEST			P	V	V	
6	LINEARITY			P	V	V	
7	RESPONSE TIME			P	V	V	
8	ENCLOSURE CLASS			P	V	V	
9	ACCESSORIES, AS APPLICABLE			P	V	V	
10	ACCURACY / CALIBRATION			P	V	V	
11	ALARM CONTACT TEST			P	V	V	
12	ANALOG OUTPUT CHECK			P	V	V	
13	BURN-IN TEST OF ELECTRONIC PARTS	1/LOT		P	V	V	
14	IN-BUILT INDICATOR, ZERO, SPAN, RANGE SCALE SELECTION ETC	SEE NOTE-1 BELOW		P	V	V	

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL,
P = Perform, W = Witness, V = Verification

Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR SOLENOID VALVES

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	TYPE						
	MAKE						
	MODEL No.						
2	MATERIAL (BODY. PLUNGER/TRIM)			P	W	V	
3	PORT SIZE			P	W	V	
4	CABLE CONNECTION SIZE			P	W	V	
5	ENCLOSURE CLASS			P	W	V	TYPE TEST CERTIFICATE TO BE FURNISHED BY VENDOR
6	No. OF COILS & INSULATION CLASS			P	W	V	TEST CERTIFICATE TO BE FURNISHED FOR INSULATION CLASS BY VENDOR
7	POWER SUPPLY CHECK			P	W	V	
8	IR / HV TEST			P	W	V	
9	FUCTIONAL TEST			P	W	V	

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR LEVEL GAUGE

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS / DRWGS	P	W	V	
	TYPE						
	MODEL/ TAG NO.						
	DAIL SIZE						
	RANGE/SCALE						
	END CONNECTION						
2	DIMENSIONS, PROCESS CONNECTION			P	W	V	
3	ACCURACY			P	W	V	
4	MATERIAL TC FOR	ONE / LOT		P	V	V	
	BODY ISO.						
	VALVE						
	GAUGE GLASS						
5	HYD. TEST	SEE NOTE-1 BELOW		P	W	V	
6	ACCESSORIES AS APPLICABLE			P	W	V	

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Manufacturer to carry out ROUTINE TEST on 100 %.
4. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.

SUB VENDOR LIST

एनटीपीसी NTPC	PROJECT :Patratu STPP (2X660 MW) PACAKGE :EPC Sub Package: Electrical Equipment Supply & Erection CONTRACTOR : M/S BHEL CONT. NO. CS-9585-001-2	LIST OF ITEMS REQUIRING QP APPROVAL & ACCEPTABLE VENDOR Contractor-M/S BHEL	REF NO : 9585-001-QOE-R-01 REVISION NO. 00 DATE 24th April 2017

Sl. No.	ITEM	QP / INS CAT.	QP No:- 9578-001-QVE-	QP SUB. SCH.	QP APPL SCHEDULE	SUB-SUPPLIERS	PLACE	SUB-SUPPLIER APPL. STATUS AS PER NTPC	SCAPPL SCHEDULE	REMARKS
13.	Junction boxes / Link Boxes/ Test Link Box/ Adopter box, Switch Boxes, Pull Boxes (Hot Dip Galvanized)	III				Main contractor approved sources with galvanization from NTPC approved sources (Note-2)		Noted		
14.	FRP Junction boxes	II	10			Main Contractor approved sources		Noted		
15.	Cable termination kits & straight through jointing kit upto 33KV	I	11			M/s 3M Electro & Communication	Pune	A		up to 33 KV
						Raychem	Mumbai	A		Heat shrinkable type up to 33 KV
						Yamuna Cable Accessories	Yamunanagar	DR		
						Hari Consolidated Pvt Ltd	Delhi	A		Heat shrinkable type Upto 11 KV with conditions, above rating DR
16.	Cable glands	III				Main contractor approved sources		Noted		
17.	Cable lugs	III				M/s Dowell	Mumbai	A		
						M/s Billets Elektro Werke Ltd.	Umbergaon	A		

Bharat Heavy Electricals Limited PS-MKTG Delhi

Patratu Vidyut Utpadan Nigam Limited C & M Deptt. Distt-Ramgarh(Jharkhand)

NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR :BHEL Ltd	VENDOR AS APPROVED BY	DATE : 26.04.2017
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9585-001-QVIQ	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
14	Tube thicknes Meter	III				Main Contractor approved sources		A				
15	POSITIVE DISPLACEMENT FLOW METER/ TRANSMITTER	III				BROOKS	USA	A			Sub QR	Calibration reports to be submitted.
		III				BOPP & ROUTHER	GERMANY	A				
		III				OVAL	JAPAN	A				
		II				Toshniwal corporation Hyvac	Chennai	A				Up to 4 Inch only
16	Coriolist Type Mass Flow meter	III				Main Contractor approved Sources		A			Sub QR	
17	Conirol Valve for Start Up System	II				CCI	USA/Switzerland/Korea	A				
		II				Tyco Sampell	Germany	A				
		II				EMERSON (Fisher)	USA/France/Japan	A				Reference list and performance feedback are to be submitted.
		*				Dressor Masoneilan	France	DR				
		II				KOSO	Japan / Nasik	A				
		II				HORA	Germany	A				
		II				CCI	Sricity	A				
18	Control valves for Soot blower pressure reducing ,SH/ RH Attemperation.	II				CCI	USA/Sweden /Korea / Austria	A				
		II				Dressor Masoneilan	France	A				
		II				HORA	Germany	A				
		II				EMERSON (Fisher)	USA/France /Japan	A				
		II				Spx Copes Vulcan	USA	A				only for SH / RH Attemperation. for Soot blower application Reference to list to be provided.
		II				KOSO	JAPAN	A				
		II				Tyco Sampell	Germany	A				
		II				Leslie	USA	A				
		I				Dressor	Coimbatore	A				Up to 2500 Class
		I				IL	Palakkad	A				Up to 2500 Class
		I				KSB MIL	Alwaye	A				
		I				KOSO	Nasik	A				
		I				EMERSON	Chennai	A				Up to 2500 Class
		I				Flow Serve	Bangalore	A				Up to 2500 Class
		I				CCI	Sricity	A				
		*				Copes Vulcan	UK	DR				
		*				Circor (Leslie)	Coimbatore	DR				
19	Control Valve for BFP Recirculation	II				CCI	USA / Austria / Korea	A				
		II				EMERSON (Fisher)	USA/France/Japan	A				
		II				Dressor Masoneilan	France	A				
		II				HORA	Germany	A				
		*				Sempell	Germany	DR				M/s BHEL will forward only three proposals after details review of NTPC Technical specification
		*				Leslie	USA	DR				
		I				CCI	Sricity	A				

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C & M Dept. Distt-Ramgarh(Jharkhand)

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NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR :BHEL Ltd	VENDOR AS APPROVED BY	DATE : 26.04.2017
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9585-001-QVI-Q	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
		*				KOSO	Japan / Nasik	DR				requirements.
		*				Nakikata	Japan	DR				
		*				Parcol Spa	USA	DR				
		*				Yamatake	Japan	DR				
		*				BOPP & ROUTHER	Germany	DR				
		*				KSB MIL	Ahwaye	DR				
20	Control valve for feedwater flow Control	II				CCI	USA/Austria /Korea	A				
		II				Dressor Masoneilan	France	A				
		II				HORA	Germany	A				
		II				EMERSON (Fisher)	USA/France /Japan	A				
		II				Sampell	Germany	A				
		II				KOSO	Japan	A				
		*				LESLIE	USA	DR				M/s BHEL will forward only three proposals after details review of NTPC Technical specification requirements.
		I				CCI	Sricity	A				
		*				Parcol Spa	USA	DR				
		*				WEIR VALVES and Controls	UK	DR				
		*				KOSO	Nasik	DR				
		*				KSB MIL	Ahwaye	DR				
		I				Emerson Process Management	Chennai	A				
		*				BOMAFA Special valve solutions Pvt. Ltd.	Ahmedabad	DR				
		*				Suzhou delan enfery science and tehnology co. Ltd.	China	DR				
21	Control Valve (other than Sr. No. - 17 to 20)	II				CCI	USA/Switzerland/Korea	A				
		II				Tyco Sampell	Germany	A				
		II				EMERSON (Fisher)	USA/France/Japan / Chennai	A				
		II				Dressor Masoneilan	France	A				
		II				KOSO	Japan	A				
		II				HORA	Germany	A				
		II				CCI	Sricity	A				
		II				Spx Copes Vulcan	USA	A				
		II				Dressor	Coimbatore	A				
		II				II	Palakkad	A				
		II				KSB MIL	Ahwaye	A				
		II				KOSO	Palakkad	A				
		II				EMERSON	Chennai	A				
		II				Flow Serve	Bangalore	A				
		II				Copes Vulcan	UK	A				
		II				Leslie	USA	A				
		II				Parcol Spa	Italy	A				
		II				KOSO	Nasik	A				

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C.E. (Mktg.) Deptt.

NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR :BHEL Ltd	VENDOR AS APPROVED BY	DATE : 26.04.2017
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9585-001-QVIQ	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
		II				Forbes Arca	Pune	A				Approvd up to 4" and 300 Class. "DR" for Higher rating and Size.
		"				Daumie Regelarmaturean GmbH	Germany	DR				M/s BHEL will forward only three proposals after details review of NTPC Technical specification requirements.
		"				Metso Singapore PTE ltd.	South Korea	DR				
		"				Severn Glocon	Chennai	DR				
		"				Spx Corporation	USA	DR				
		"				Ringo Valvulas SL	Spain	DR				
		"				Valvitalia SPA	Italy	DR				
		"				R K Controls	Thane	DR				
		"				Circor (Leslie)	Coimbatore	DR				
		"				Spx Flow Technologies	USA	DR				
		"				Circor (Leslie)	Coimbatore	DR				
		"				Schenjiang valve co. ltd.	China	DR				
		"				Spx Flow Technologies	Ahamadabad	DR				
		"				WEIR Valves and Controls	UK	DR				
		"				WALDEMAR PRUSS ARMATURENFABRIK GMBH	Germany	DR				
		"				BOMAFA Special valve solutions Pvt. Ltd.	Ahmedabad	DR				
		"				Suzhou delan enfery science and tehnology co. Ltd.	China	DR				
22	Temperature Transmitter	III				EMERSON	U.S.A/Pawane / Singapore	A			Sub QR	
	(Single and Dual Input)	III				Yokogawa	Japan	A				Final testing at M/S YIL,Bangalore is also acceptable
		III				Moore	USA	A				
		III				M System	JAPAN	A				
		III				ABB	GERMANY/ Bangalore	A				
		III				ENDRESS & HOUSER	Aurangabad	A				
		"				Khrone		DR				M/s BHEL will forward only two proposals after details review of NTPC Technical specification requirements.
		"				Tokyo Kelso	Japan	DR				
		"				Honeywell	Pune	DR				
		"				ENOR	Sweden	DR				
		"				P & F	Bangalore	DR				
		"				Siemens		DR				
		"				Yamatake	JAPAN	DR				
		"				Yamari	JAPAN	DR				
		"				Foxboro		DR				
23	Conduits/Pipe(GI)					Refer Electrical List						
24	Electronic transmitters (pressure, DP,Flow)	III				EMERSON (Rosemount)	USA/ Pawane	A			Sub QR	
		III				FUJI ELECTRIC	France	A				
		III				YOKOGAWA	JAPAN	A				Testing and Calibration at M/s YIL, Bangalore is also acceptable.

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NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR :BHEL Ltd	VENDOR AS APPROVED BY	DATE : 26.04.2017
	CONTRACT NO : CS-9565-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9565-001-QVP-Q	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
		III				YOKOGAWA	Bangalore	A				EJA- E series 110,430,530
		III				ABB	Bangalore	A				Model - 2600 T
		III				ABB	GERMANY / Italy	A				Model - 2600 T
		III				Siemens	France / Kalwa	A				
		III				Honeywell	Pune	A				
		III				Laxson Automation	Daman	A				SMAR Make
		III				Baldota	Mumbai	A				SMAR Make
		*				ENDRESS & HOUSER	Aurangabad/ Germany	DR				
		*				CHINO	Ghaziabad	DR				
25	Thermocouples, RTD & Thermowell	III				HERAUS SENSOR	GERMANY	A			Sub QR	
		III				WISE Control	Korea	A				
		II				Tempsens	Udaipur	A				
		II				Pyroelectric	Goa	A				
		II				Delnv Instrumentation & Electronics Ltd	Mumbai	A				
		III				Minco	USA	A				
		III				OKAZAKI corporation	JAPAN	A				
		III				Yamari	JAPAN	A				
		III				Yamari	Singapore	A				For RTD Reference list and Performance feedback is to be submitted.
		III				ABB(SENSYCON)	Germany	A				
		III				EMERSON (Rosemount)	Germany	A				
		II				EMERSON (Rosemount)	Pawane	A				Imported from Emerson, Germany (make)
		II				Thermal Instruments(GIC)	Savantwadi	A				
		II				Techno Instruments	Ahamadabad	A				
		II				GOA Instrument Industries	GOA	A				For Thermowell only
		*				GOA Instrument Industries	GOA	DR				M/s BHEL will forward only two proposals after details review of NTPC Technical specification requirements.
		*				WIKA	Pune	DR				
		*				Toshniwal Industries	Ajmer	DR				
		*				E & H	Aurangabad	DR				
		*				Nesstech	Vapi	DR				
		*				Instrustial Instruments	Kolkata	DR				
		*				Exotherm	Thane	DR				
		*				Baumer Technologies	Vapi	DR				
		*				Eleind Engineering	Noida	DR				
		*				Siemens India	Gurgaon	DR				
		II				Jindal Electronics	Roorkee	A				For Gentrator turbine & Motor
26	Ultrasonic type level Transmitter	III				E & H	Aurangabad/ Germany	A			Sub QR	
		III				EMERSON	Pawane	A				
		III				SIEMENS MILTRONICS	CANADA	A				
		III				Nivelco	Hungery	A				
		*				Vega	Gennany	DR				

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Bharat Heavy Electricals Limited PS-MKTG Delhi

C & M Deptt.

Patratu Vidyut Utpadan Nigam Limited Distt.Ramgarh(Jharkhand)

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NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR :BHEL Ltd	VENDOR AS APPROVED BY	DATE : 26.04.2017
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9585-001-QVIQ	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
		*				Khrone	France / USA / Pune	DR				M/s BHEL will forward only two proposals after details review of NTPC Technical specification requirements.
		*				Yokogawa	Bangalore	DR				
		*				P&F	Germany	DR				
		*				Magnetrol	Belgium	DR				
		*				ABB	Germany / India	DR				
		*				Fobes Marshell	Pune	DR			Sub QR	
27	Orifice plate assembly	III				Instrumentation Limited	Palghat	A				
		III				Microprecision	Patwal	A				
		III				Starmech	Pune	A				
		III				Flow Star	Faridabad	A				
		III				SEIKO	Austria	A				
		III				MINCO India Pvt. Ltd.	GOA	A				Up to 32"
		III				MINCO India Flow Elements Pvt. Ltd.	GOA	A				Up to 28"
		III				WISE Control	Korea	A				
		III				T M Technomatic	Italy	A				
		*				IEPL	Hyderabad	DR				
		*				Engg. Specialities	Kolkata	DR				
		*				BALIGA	CHENNAI	DR				
		*				Pyroelectric	Mumbai	DR				
		*				Hydropneumatics	Mapusa	DR				
		*				Tensa Equipment Pvt. LTd.	Thane	DR				
		*				Dynamic Fluid Vales Pvt. Ltd.	Belgaum	DR				
28	Pressure, DP Gauge	III				BUDENBERG	UK	A				
		III				ASHCROFT	USA/Germany/ India	A				
		III				Wika	GERMANY	A				
		III				WISE Control	Korea	A				
		III				Nagano KEIKI	Japan	A				
		III				H.Guru South India	Bangalore	A				Not for MS & FW application
		III				A.N. Instruments	Kolakata	A				Not for MS & FW application
		III				Gauge Bourdon	Panvel	A				
		III				Goa Thermostatic	GOA	A				Not for MS & FW application
		III				Wika	Pune	A				DR for MS & FW application
		III				Baumer	Vapi	A				DR for MS & FW application
		III				Precision mass products Pvt. Ltd.	Gandhinagar	A				Not for MS & FW application
		III				H Guru	Rishra/Muzaffarpur	A				Not for MS & FW application
		*				US Gauge	USA	DR				
		*				Winters	USA	DR				
		III				Forbes Marshall	Hyderabad	A				
		*				Manometer	Mumbai	DR*				
		III				Walchandnagar Industries Ltd.	Dharwad	A				
		III				Nesstech	Vapi	A				DP Gauge for M/s Nesstech, Japan
		*				Gauges Bourdon	UK	DR				
		*				Fisher Mess	Germany	DR				

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NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR : BHEL Ltd	VENDOR AS APPROVED BY	DATE : 26.04.2017
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9585-001-QVIQ	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
		*				Protech Control	Kolkata	DR				
		*				New Scientific	Kolkata	DR				
		*				PTCI	Kolkata	DR				
29	Level gauge (Transperent & Reflex, Tubular type)	III				Main Contractor approved Sources		A				
30	Press, DP, Vaccum Switch	III				SOR	USA	A			Sub QR	
		III				DRESSOR (ASHCROFT)	USA/Germany	A				
		III				ITT BARTON	USA	A				
		III				HERION	GERMANY	A				
		III				BARKSDALE	GERMANY	A				
		*		*		Nagano KEIKI	Japan	DR				
		II				Switzer Process Instrument	Chennai	A				Up to 40kg/cm2 & not for Compound Switch and except 900 series
		II				Trafag	Gurgaon	A				Up to 40kg/cm2 & not for Compound Switch
		II				Switzer Process Instrument	Ghaziabad	A				Up to 40kg/cm2 & not for Compound Switch
		III				Delta control	UK	A				
		I				Gauges Bourdon (GIC)	Panvel	A				Up to 40kg/cm2 & not for Compound Switch
		I				ASHCROFT	Gandhinagar	A				
		*				Wika	Pune	DR				
		III				Gergeion	France	A				
		III				United Electric	USA	A				M/s BHEL will forward only two proposals after details review of NTPC Technical specification requirements.
		*				SMC	Japan	DR				
		*				Neodyne	USA	DR				
		*				IMI NORGEN	Noida	DR				
		*				WISE Control	Korea	DR				
		*				Baumer	Vapi	DR				
		*				Vasu Tech	New Delhi	DR				
		III				Bgit & Krich	Germany	DR				
31	Temperature Switch	III				SOR	USA	A			Sub QR	
		III				DRESSOR (ASCHROFT)	USA/Germany	A				
		III				ITT BARTON	USA	A				
		III				DELTA CONTROLS	UK	A				
		I				Switzer Process Instrument	Chennai	A				up to 200 Deg. C
		I				Switzer Process Instrument	Ghaziabad	A				up to 200 Deg. C
		II				Trafag	Gurgaon	A				up to 200 Deg. C
		I				ASHCROFT	Gandhinagar	A				
		*				Wika	Pune	DR				
		III				Gergeion	France	A				
		III				United Electric	USA	A				
		*				SMC	Japan	DR				
32	Flow switch	III				UNIVERSAL FLOW METER	USA	A			Sub QR	
		III				Switzer	Chennai	A				

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Patratu Vidyut Utpadan Nigam Limited C&M Deptt. Distt. Ramgarh (Jharkhand)

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NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR :BHEL Ltd	VENDOR AS APPROVED BY	DATE : 26.04.2017
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9585-001-QVIQ	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
		III				Levcon	Kiokatta	A				
		III				DK Instrument	Kolkatta	A				
		III				Khrone Marshal	Pune	A				
		III				Chemtrol	India	DR				
		III				V Automat	NewDelhi	DR				
		III				Gauges Bourdon	Panvel	A				
		III				Magnetrol	Belgium	A				
		III				Ashcroft	Germany	A				
		III				Auxitrol	UK	A				
		III				Mericoid	USA	A				
		III				Delta Control	UK	A				
		III				Merlum	USA	A				
		*				Sunag Corporation		DR				
33	Condensing Pots	III				Main Contractor approved Sources		A				
34	Electric to Pneumatic converter	III				IMI NORGEN	India	A			Sub QR	Make : WATSON SMITH
		III				Fair child	USA	A				
		*				ABB	India	A				Subject to meeting the NTPC specificaion requirement
		*				SMC Pneumatics	Noida	DR				
		*				P & F	Bangalore	DR				
		*				Fairchild India Pvt. Ltd.	Noida	DR				
		*				FESTO	Bangalore	DR				
35	Conduits lead coated (Flexible)	III				Plica	Ghaziabad	A				Main contractor can propose additional vendor for this item
		III				Bansal labortories	BHOPAL	A				
36	Intelligent Battery charger 24V DC & DCDB /BHMS	II				Chabbi Electricals	Jalgaon	A			Sub QR	Modules from EMERSON
		II				Eltech	Gurgaon	A				Modules from ELTEK
		II				MasTech	Jalgaon	A				Modules from ELTEK
		II				Emerson	India	A				
		II				MasTech (Selek Modules)	Jalgaon	A				BHMS from M/s USV, Germany
		*				HBL Power Systems	India	DR				
		*				Dobas	India	DR				
		*				Chabbi Electricals (Chabbi Modules)	Jalgaon	DR				
		*				Hitachi Hi Rel	Gandhinagar	DR				
		*				Statcon Power Controls Pvt. Ltd.	Noida	DR				
		*				Chloride Power Systems (caldyne)	India	DR				
		*				Amararaja	Tirupati	DR				
		*				Keltron Power Electronics	Trivendram	DR				

M/s BHEL will forward only two proposals after details review of NTPC Technical specification requirements.

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Patratu Vidyut Utpadan Nigam Limited * Distt-Ramgarh (Jharkhand) * C & M Deptt.

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NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR :BHEL Ltd	VENDOR AS APPROVED BY	DATE : 26.04.2017
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9585-001-QVI-Q	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
		*				Universal instrument manufacturing co P Ltd	India	DR				
		*				Hind Rectifier Ltd	India	DR				
37	Battery Health Monitoring System	III				Emerson	Mumbai	A				
		III				Elek SGS Pvt Ltd	Gurgaon	A				
		*				B Tech Inc	USA	DR				
		III				Hitachi Hi Rel	Gandhinagar	A				
		*				Hopeckes	Germany	DR				
		*				Hitachi Hi Rel	Gandhinagar	DR				
38	Battery(Ni-cd)	I				AMCO SAFT	Bangalore	A				
		II				SAFT	France/Sweeden	A				
		I				HBL POWER	Hyderabad	A				
		II				Hopekee	Germany	A				
39	Socket weld fittings	III				BHEL Approved Sources						
40	Impulse pipe & tubes	II				Mahrashtra Seamless	Raigarh	A				Carbon steel only
		II				Sumitomo/kawasaki/Nippon	Japan	A				
		II				TPS TECHNITUBE	Germany	A				
		II				Veluric & manessmann	Germany	A				
		II				BHEL	Trichy	A				
		II				Trouvay and Cauvin	France	A				Makes shall be as per approved list (Sr. No. 41)
		II				ISMT	Ahamadnagar	A				Carbon steel only.
		II				Sandvik		A				For SS only.
		*				TUBACES	Spain	DR				
		*				Salzgitter Mannesmann International	Germany	DR				
		*				Jindal saw	India	DR				
		II				Ratanamani Metal and Tubes	Ahamadabad	A				SS only
		II				Heavy metals and Tubes	Ahamadabad	A				SS and CS only.
		*				Shubhalaxmi Metal and Tubes	Mumbai	DR				
41	Compression fittings	III				Parker	USA	A				
		III				Precision	Mumbai	A				
		III				Astech	Mumbai	A				
		III				Fluid control Pvt. Ltd.	Pune	A				
		III				HP Valves and fittings	CHENNAI	A				Ferrulees are to be hardned at Exim Holand for pressure above 9000 psi.
		III				Excel hydro	Mumbai	A				Ferrulees are to be hardned at Exim Holand for pressure above 9000 psi.
		III				Swagelock	USA	A				
		III				Panam	Mumbai	A				
		III				Melpress	Kolkatta	DR				
		*				AURA INC	New Delhi	DR				
		*				Prime Engineers		DR				
		*				Arya Craft		DR				

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Patratu Vidyut Utpadan Nigam Limited * Distt-Ramgarh (Jharkhand)

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NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR :BHEL Ltd	VENDOR AS APPROVED BY	DATE : 26.04.2017
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9585-001-QVIQ	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
		*				PMT Engineers	Ahemdabad	DR				
		*				Flowtech	Kolkatta	DR				
		*				Parker Hannifin India Pvt Ltd		DR				
42	Instrument valves	III				BHEL	Trichy	A				
		II				Excel Hydro	Mumbai	A				
		II				Instrumentation Ltd.,	Palghat	A				
		III				Swagelok	USA	A				
		III				Parker	USA	A				
		II				HP Valves and fittings	CHENNAI	A				
		II				Fluid control Pvt. Ltd.	Pune	A				
		II				Baldota	Mumbai	A				
43	Valve manifolds	III				Excel hydro	Mumbai	A				
		III				SCHNEIDER	Germany	A				
		III				Anderson Greenwood	USA	A				
		III				Astech	Mumbai	A				
		III				HP Valves and fittings	CHENNAI	A				
		III				Fluid control Pvt. Ltd.	Pune	A				
		III				Microprecision	Faridabad	A				
		III				Parker	USA	A				
		III				Swagelock	USA	A				
		III				Baldota	Mumbai	A				
		*				Metpress Engg. works	Kolkata	DR				
		*				Flow tech	Kolkata	DR				
44	Local Instrument Enclosure/Rack	I				Pyrotech	Udaipur	A				
		I				Instrumentation Limited	Kota	A				
		I				Sajas electrical	Trichurapalli	A				
		I				Prammen	Puddukottai	A				
		I				Chemin	Pondicherry	A				
		*				Forbes Marshall	Pune	DR				
		*				Pasitronics	Vadodara	DR				
		*				Procon	Chennai	DR				
45	Instrument Cables	I				Paramount	Khushkhera	A				PVC,FRLS type,ROP
		I				Polycab	Daman	A				PVC,FRLS type,ROP
		I				Delton	Faridabad	A				PVC,FRLS type,ROP
		I				KEI	Bhiwadi	A				PVC,FRLS type
		I				Elkey Telelinks	Faridabad	A				PVC,FRLS type
		I				CORDS	Chopanki	A				PVC,FRLS type,ROP
		I				CORDS	Kaharani	A				PVC,FRLS type,ROP
		I				Nicco	Kolkata	A				PVC,FRLS type
		II				TEW & C	USA	A				
		II				Habia cables	Sweeden	A				
		II				Kerpen cables	Germany	A				
		II				Lapp cables	Germany	A				
		II				Thermo electra Bv	Netherland	A				
		I				Universal Cable	Satna	A				PVC,FRLS type
		I				Thermocables	Hyderabad	A				PVC,FRLS type

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C & M Deptt. Patratu Thermal Power Station Limited * Dist. Ramgarh (Jharkhand)

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NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR :BHEL Ltd	VENDOR AS APPROVED BY	DATE : 26.04.2017
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9585-001-QVIQ	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
		I				Finolex Cable	Pune	DR *				
		I				Incab	Pune	DR *				
		I				Gupta Power Infrastructure Ltd.	Khurdha	A				
		*				Lapp cables	India	DR				
		*				Lioni cable	Pune	DR				
		*				RR Kabel	Silvasa	DR				
		*				Gemscab	Bhiwadi	DR				
		*				KEC International	Mysore	DR				
		*				Advance cable Technologies	Bangalore	DR				
		*				Suyog Electricals Ltd.	Vadodara	DR				
		*				Special Cable	India	DR				M/s BHEL will forward only two proposals after details review of NTPC Technical specification requirements.
		*				CMI	Faridabad	DR				
		*				Govind Cables	Kolkata	DR				
		*				Associate Cables	Mumbai	DR				
		*				Radiant RSCC Speciality	Hyderabad	DR				
		*				APAR Industries	Banglore	DR				
		*				Tempsens Cable	Udaipur	DR				
		*				Mansfield cables co. Ltd.	Hyderabad	DR				
		*				Servel India Pvt. Ltd.	Neemrana	DR				
		*				TC Communication Pvt. Ltd.	Ghaziabad	DR				
46	Electrical actuator	III				Auma	Germany	A				
		III				Limitorque	USA	A				
		III				Rotork	UK	A				
		II				Limitorque	Faridabad	A				
		II				Rotork	Chennai/ Bangalore	A				
		III				Nippon gear	Japan	A				
		II				Auma	Bangalore	A				
		III				Harold Beck	USA	A				
		III				Drehmo	Germany	A				
		I				Antrieb	Chennai	A				For Low torque application such as SH/RH vent, circulation isolation
		*				Lindco	USA	DR				
		*				Siemens	Germany	DR				
47	Electrical actuator for ID/FD/PA Blade pitch and Guide vane control	III				Harold Beck	USA	A				
		III				SIPOS Aktorik GmbH	Germany	A				
		*				ABB	Germany	DR				
48	Flow nozzle / Venturi assembly	II				Microprecision	Faridabad	A			Sub QR	
		II				SEIKO	Austria	A				
		II				TECHNOMATIC	Italy	A				
		II				Instrumentation Limited	Palghat	A				
		I				Starmech	Pune	A				
		II				WISE Cehtrol	Korea	A				

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C & M Deptt. Patratu Thermal Power Station Dist-Ramgarh (Jharkhand)

NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR :BHEL Ltd	VENDOR AS APPROVED BY	DATE : 26.04.2017
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9585-001-QVIQ	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
		I				MINCO India Flow Elements Pvt. Ltd.	GOA	A				
		*				SAMIL	Korea	DR				
		*				MINCO	GOA	DR				
		*				Engg. Specialities	Kolkata	DR				
		*				Pyroelectric	Mumbai	DR				
		*				Hydropneumatics	Mapusa / GOA	DR				
		*				ASIAN INDUSTRIAL VALVES	Chennai	DR				
		*				Dynafluid valves Pvt. Ltd.	Belgium	DR				
49	HIGH Temp. cable (PTFE/FEP)	II				Habia cables	Sweden	A				
		II				Lapp cables	Germany	A				
		II				Kerpen cables	Germany	A				
		II				TEW & C	USA	A				
		II				Thermo-Electra Bv	Netherland	A				
		II				Habia cables	China	A				
		II				Thermocables	Hyderabad	A				
		II				Tempsens	Udaipur	A				
		*				Delton Cables	Faridabad	DR				
		*				RJ Cables	Roorkee	DR				
50	Fiber optic cable	II				HFCL	Goa	A				
		II				R&M	Switzerland	A				
		II				Aksh Fibre	Bhiwadi	A				
		II				Finolex	Pune/Goa	A				
		II				Birla Ericson	Rewa	A				
		II				Molex	UK	A				
		II				Corning	USA	A				
		II				Schneider	GOA	A				Previously known as D Link / Smartlink, Goa
		*				RPG Cables	India	DR				
		*				Uniflex Cables	India	DR				
		*				Terracom	India	DR				
51	Pneumatic Actuator (Power Cylinder e. g. FOR SADC)	II				Dong Woo Valve Control Co, LTD	Korea	A				
		II				Shin Hwa Engineering Co. LTD	Korea	A				
		I				Instrumentation Limited	Palghat	A				
		I				Kelton	Cochin(Alleppy)	A				
		I				SMC Pneumatics	Noida	A				Up to 12 inch only
		I				Rotex	Mumbai	A				Conditional
		*				Emerson Process Management	Chennai	DR				
		*				MIL Controls	Alwaye	DR				
		*				Festo	Bangalore	DR				
		*				IMI Norgen	Noida	DR				
52	Level switch capacitance type	III				ENDRESS & HOUSER	Aurangabad	A			Sub QR	
		III				MAGNETROL	BELGIUM	A				
		III				SBEM	PUNE	A				
		III				PUNE TECHTROL	PUNE	A				

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Patratu Vidyut Utpadan Nigam Limited ★ Distt-Ramgarh (Jharkhand) C&M Deptt.

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NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR :BHEL Ltd	VENDOR AS APPROVED BY	DATE : 26.04.2017
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9585-*-001-QVI-Q	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
		III				LEVCON	KOLKATA	A				
		III				Nivo Controls	Indore	A				
		*				V AUTOMAT	New Delhi	DR				
		*				D K Instrument	Kolkata	DR				
		*				Siemens	Germany	DR				
		*				ABB	Korea	DR				
		*				Rosemount	Korea	DR				
53	Transducer	II				AE	Mumbai	A				
		II				Southern Transducer	Chennai	A				
		II				Elster	Mumbai	A				
		III				Camille Bauer	Germany	A				
		III				Metrawat	Germany	A				
		II				Rishab	Nasik	A				
		*				Pyrotech	Udaipur	DR				
		*				Masibus	Gandhinagar	DR				
		*				SIEMENS	Germany	DR				
54	Mini UPS up to 3.5 KVA	III				EMERSON	Mumbai	A				
		III				EMERSON	Pune	A				
		III				Hitachi Hi- Rel	Gandhinagar	A				
		III				APC	Bangalore	A				
		III				APLAB	Mumbai	A				
		III				Delta	Gurgaon	A				
		*				Powertronix	Bangalore	DR				
		*				DUBAS ENGG.PVT.LTD., BANGALORE		DR				
		*				Grid power conversion Pvt Ltd.		DR				
		*				Schneider	Bangalore	DR				
55	Level switch- cond type	III				EMERSON (Solartron mobrey)	UK	A			Sub QR	
		II				Hi Tech	Kolkata	A				Levelstate, UK System
		III				Yarway	USA	A				
		III				LEVELSTATE	UK	A				
		II				Raman Instruments	Delhi	A				Emerson (Mobrey) System
		*				BHEL	Trichy	DR				
		*				IGEMA	Germany	DR				
56	Level switch - Float/Displacer Type	III				ENDRESS & HOUSER	AURANGABAD	A			Sub QR	
		III				MAGNETROL	BELGIUM	A				
		III				LEVCON	KOLKATA	A				
		III				SBEM	PUNE	A				
		III				Chemtrols samil	Mubmai	A				
		III				NAKATIYA	JAPAN	A				
		III				Sigma Industries	Mubmai	A				
		III				D K Instrument	KOLKATA	A				
		III				PUNE TECHTROL	PUNE	A				
		III				V AUTOMAT	NEW DELHI	A				
		*				WAREE	WAPI	DR				
		III				LEVELSTATE	UK	A				

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NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR :BHEL Ltd	VENDOR AS APPROVED BY	DATE : 28.04.2017
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9585-001-QVIQ	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
		III				Gauges Bourdon (GIC)	Panvel	A				
		*				Nisan Scientific Process	Navi Mumbai	DR				
57	Air filter regulator	III				Fairchild	USA	A				
		III				Shavo Norgen	Mumbai	A				
		III				SMC Pneumatics	NOIDA	A				
		III				Emerson (Asco)	Chennai	A				
		III				Festo	Bangalore	A				
		III				Placka	Chennai	A				
						Divya Control Elements	Gujarat	DR				
58	Copper tubing/Brass connectors	III				Main Contractor approved Sources		A				
59	Coupling / Interposing relays	III				PARAMOUNT	BANGALORE	A				
		III				OMRON		A				
		III				OEN		A				
		III				Jyoti	Baroda	A				
		III				ELSTA	SWITZERLAND	A				
		*				Schneider	Germany	DR				
		*				Siemens	Germany	DR				
		*				Phoenix	Germany	DR				
		*				Finder		DR				
60	Solenoid valve	III				Rotex	Vadodara	A			Sub QR	
		III				Avcon	Mumabi	A				
		III				Herion	Germany	A				
		III				IMI NORGEN	GERMANY	A				
		III				Jafferson	Argentina	A				
		III				Asco	Chennai/USA	A				
		III				Festo	Bangalore	A				
		III				SMC	Noida	A				
		III				Parker	Brand Name	A				
		*				Schneider	Germany	DR				
		*				Neucon Industries Pvt. Ltd.		DR				
61	Lube oil control valve - Self Regulating	III				NUOVO PIGNONE	ITALY	A				
		III				EMERSON	CHENNAI	A				
		III				SAMSON	GERMANY / PUNE	A				
		III				Forbes marshall arca pvt. Ltd.	Pune	A				Approved up to 16", 900 Class.
62	Guided waveRadar type level transmitter	III				Magnetrol	Belgium	A			Sub QR	
		III				Endress & Houser	Germany/ Aurangabad	A				
		III				Emerson Process Management	Sweden/ PAWANE	A				
		III				ABB(K-Tech)	USA	A				
		II				Supreme Technology	Thane	A				Make M/s Siemens, Canada
		*				Yokogawa	Japan	DR				
		*				ABB	India	DR				
		*				P & F	Bangalore	DR				

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NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR : BHEL Ltd	VENDOR AS APPROVED BY	DATE : 26.04.2017
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9585-001-QVI-Q	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
		*				Khrone	France	DR				
		*				HONEYWELL	Pune	DR				
		*				Vega	Germany / India	DR				
		*				Siemens	India	DR				
		*				SBEM	Pune	DR				
63	Maintenance and Calibration Equipment					Main Contractor will propose the vendors during detail Engineering.						
64	Temperature Gauge	III				SUDENBERG	UK	A				
		III				DRESSOR (ASHCROFT)	USA/Germany	A				
		III				Wika	GERMANY/ Pune	A				
		III				WISE Control	Korea	A				
		III				Nagano KEIKI	Japan	A				
		III				H.Guru South India	Bangalore	A				
		III				A.N. Instruments	Kolakatta	A				
		III				NUOVA FIMA	ITALY	A				
		III				Goa Thermostatic	Goa	A				
		III				Goa Instrument Industries	Goa	A				
		III				Baumer	Vapi	A				
		III				Precision mass products Pvt. Ltd.	Gandhinagar	A				
		III				H Guru	Rishra/Muzaffarpur	A				
		III				Baumer	Vapi	A				
		III				Forbes Marshal	Hyderabad	A				
		III				Gauges Bourdon (GIC)	Panvel	A				
		*				Konics	Korea	DR				
		*				Pyroelectric	GOA	DR				M/s BHEL will forward only two proposals after details review of NTPC Technical specification requirements.
		*				Winters Gauge	USA	DR				
		*				Walchandnagar Industries Ltd.	Dharwad	DR				
		III				Nasstech	Vapi	A				
		*				US Gauge	USA	DR				
65	Furniture for computer (Chair, Almirah, Lock etc.)	III				Main contractor approved sources		A				
66	Terminal Block (Cage and Clamp type)	III				Weidmuller	Germany	A				
		III				Phoenix	Germany / India	A				
		III				Wago	Germany / India	A				
		III				Elmex	Vadodara	A				CE Mark only
67	FRP Junction Box for C&I system	III				BHEL Approved Sources		A				
68	PLC System (if applicable)	I				GE Intelligent plateforms	Bangalore	A				
		I				ABB	Bangalore	A				
		I				Schneider	Nasik	A				
		I				Rockwell	Sahibabad	A				
		I				Siemens	Nasik	A				
		I				HONEYWELL	Pune	A				
69	SMART POSITIONER (Make)	#				ABB						# - To be covered in Control Valve QP.

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NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR : BHEL Ltd	VENDOR AS APPROVED BY	DATE : 26.04.2017
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9585-001-QVIQ	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
		#				Masoneilan						
		#				Siemens						
		#				Smar						
		#				Yokogawa						
		#				EMERSON (Fisher Rosemount)						
		#				METSO						
		#				Yamatake						
		#				Moore						
70	ROTAMETER	III				IEPL	HYDRABAD	A			Sub QR	
		III				TRAC	HYDRABAD	A				
		III				PLACKA	CHENNAI	A				
		III				EUREKA	PUNE	A				
		III				SCIENTIFIC DEVICES	MUMBAI	A				UP TO 300 NB
		III				FLOW STAR	FARIDABAD	A				
		III				TOKOYO KEISO	JAPAN	A				
		*				Flowtech Instrument Services	Vadodara	DR				
		*				Samil Chemtrol	MUMBAI	DR				
		*				Gauges Bourdon	Panvel	DR				
		*				Tensa Equipment Pvt. Ltd.	Thane	DR				
71	SINGLE AND MULTI POINT TEMPERATURE RECORDER (Microprocessor based)	III				YOKOGAWA INDIA	BANGALORE	A				Make Yokogawa, Japan
		III				CHINO CORPORATION	JAPAN	A				
		III				EUROTHERM	UK	A				
		III				EUROTHERM	INDIA	DR				
		III				YOKOGAWA	JAPAN	A				
		III				ABB	UK / GERMANY	A				
		III				FUJI	JAPAN	A				
		III				HONEYWELL	USA / NETHERLAND	A				
72	Reverse Rotation Indicator (RRI)	III				GE BENTLY NEVEDA	USA	A			Sub QR	ALL TSI VENDORS ARE ALSO ACCEPTABLE
		III				SHINKAWA	JAPAN	A				
		I				P & F	Bangalore	A				
73	Instrument Tube Fittings (Air)	III				Main contractor approved sources		A				
74	pH/ Conductivity Analyser	III				HACH	Switzerland / USA	A			Sub QR	
		III				YOKOGAWA	Banglaore / Japan	A				Make Yokogawa- Japan
		III				ABB	UK / USA	A				
		III				EMERSON	Pawane	A				
		*				Thermo orion		DR				
		*				Forbes Marshell	Pune	DR				
75	PADO					Main Contractor will propose the vendors during detail Engineering.						
76	DEW Point Sensor / meter/ Moisture Measuring System	III				GE Sensing	USA / Ireland	A				Panametric brand
		III				Michell Instrument	UK	A				
		III				Shaw	UK	A				

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NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR :BHEL Ltd	VENDOR AS APPROVED BY	DATE : 26.04.2017
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9585-001-QVIQ	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
		III				COSA XENTAUR	USA	A				through Spectrum automation faridabad
		*				VAISHALA	Sweden / Japan	DR				
		*				DWER	USA	DR				
		*				Endee	Mumbai	DR				
		*				Nivo Controls	Indore	DR				
		*				Bartec GMBH	Germany	DR				
77	Blank Panels / Cabinets	III				Rittal	Bangalore	A				
		III				Hoffman	BANGALORE	A				
		III				Pyrotech	Udaipur	A				
		III				BHEL	Bangalore	A				
		III				Schneider	Bangalore	DR				
78	CCTV Components (IP)	*				Sony	Japan	DR				
		*				Siemens	Pondichery	DR				
	Integrators will be decided during detail Engineering.	*				Dv Tel	USA	DR				
		*				Honey Well	Gurgaon	DR				
		II				Bosch	Bangalore	A				With Bosch Software
		II				Axis	Sweden	A				With Bosch Software
		*				Pelco	USA	DR				
		II				Axis	Sweden	A				With Milestone Software
79	Control Desk, Server / PC Rack for Unit Control room and Auxiliary control room.	I				Pyrotech works Space	Udaipur	A				
		I				Cosmos	Noida	A				
		I				Adarsh Control	Bangalore	A				
		*				Chemin Controls	Pondichery	DR				
		*				Harmoney Systems	New Delhi	DR				
80	Digital Indicators	III				Masibus	Gandhi Nagar	A				For Non mosaic mounting
		III				ABB	Germany	A				
		III				Foxboro	UK	A				
		III				Yokogawa	Japan	A				
		III				Gossen / Metrowatt / Camille Bauer	Germany	A				
		III				Siemens	Germany	A				
		III				Chino	Japan	A				
		III				Weigell Messgerate	Germany	A				
		III				Pyrotech	Udaipur	A				For Non mosaic mounting
		*				Chino Corporation	Mumbai	DR				
		*				Yokogawa	Bangalore	DR				For Non mosaic mounting and submit only two proposals
		*				Lekzrotek	Pune	DR				
		*				Telecherm	Chennai	DR				
81	Dust Emision Monitor	III				Land Instrument International	UK	A				Land Combustion Division
		III				Durag	Germany	A				
		III				Sick Maihak	Germany	A				
		III				Emerson Process Management	Ireland	A				
		III				Codel	UK	A				

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NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR :BHEL Ltd	VENDOR AS APPROVED BY	DATE : 26.04.2017
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9585-001-QVIQ	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
		III				Elster	Mumbai	A				
		III				Secure Meters	Udaipur	A				
		III				Yokogawa	Japan	A				
		III				GEC	UK	A				
		III				Schnieder Electric	India	DR				
		III				Landis + Gyr	Kolkata	DR				
109	Wireless Solution (Microwave Tower Communication)	III				D Link	Goa	A				
		III				Sheetal	Pune	A				
		III				Pyrotech	Udaipur	A				
		III				Arya Communications	New Delhi	A				
		*				Lotus Wireless	Vishakhapatnam	DR				
		*				Avirion	Israel	DR				
		*				Prudent Automation Pvt. Ltd.	Hyderabad	DR				
		*				AMG Systems Ltd.	UK	DR				
110	Large Video Screen (LED Based)	III				Delta	Gurgaon	A				
		III				Barco	Noida	A				
		III				Planer System	USA	A				
		*				Christie	USA	DR				
		*				Eyevis	Germany	DR				
111	CJC Box (If applicable)					Main Contractor will propose the vendors during detail Engineering.						
112	3 D level Scanner for Solid Application	III				APM	ISRAIL	A				
113	Dust Sensor	III				BHEL Approved Sources		A				
114	Pulse jet Controller	III				Switching Circuit	Kolkata	A				
		III				Advance Concept	Kolkata	A				
		III				Control Devices	Kolkata	A				
		*				Vollcraft	Kolkata	DR				
		*				Micro System	Kolkata	DR				
115	Solid Mass Flow Meter	III				Schenk	Ranchi	A				
		III				Thermofisher (Ramsay)	Nasik	A				
		III				Siemens Miltronics	Canada	A				
		III				Mutec	Germany	A				
		III				SWR	Germany	A				
116	Nucleonic Density meter	III				E & H	Aurangabad	A				
		III				Thermofisher Scientific	UK	A				
		*				Siemens	Germany	DR				
		*				EMERSON	USA	DR				
		*				GE Sensing	USA	DR				
		*				Berthhold	Germany	DR				
117	Humidistat / Thermostat / Gyserstat / Airstat	III				BHEL Approved Sources		A			Sub QR	
118	Level Switch (RF Type)	II				EIP Enviro	Noida	A			Sub QR	
		II				FLOW STAR	Faridabad	A				
		II				Nivo Controls	Indore	A				
		*				BHEL		DR				

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Patratu Vidyut Utpadan Nigam Limited ★ Distt-Ramgarh(Jharkhand) Deptt.

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NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR :BHEL Ltd	VENDOR AS APPROVED BY	DATE : 26.04.2017
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9585-001-QVIQ	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
119	Turbine supervisory instruments along with vibration analysis system.	II				GE BENTLY	USA	A				
	Refer Note - 1	II				MEGGITT (VIBROMETER)	SWITZERLAND	A				
		II				SHINKAWA	JAPAN	A				
		I				GE	Pune	A				For GE Bently, USA System
		I				MEGGITT (VIBROMETER)	Bangalore	A				For Meggitt, Switzerland System
		I				Forbes Marshall	Pune	A				For Shinkawa, Japan system
		*				EMERSON	INDIA	DR				
		*				Bruel and Kjaer		DR				
		*				Rockwell Automation	Sahibabad	DR				
		*				SKF	USA / India	DR				
		*				BHEL EDN	Bangalore	DR				
120	SWAS (Sampling Handling System and Dry Panel)	I				Emerson Process Management	Navi Mumbai	A			Sub QR	
		I				Forbes Marshall	Pune	A				
		I				Lowe	UK	A				
		I				ABB	Bangalore	A				Conditional
		I				Yokogawa	Bangalore	DR				
		I				Analyser Instrument Co. Ltd.	Kota	DR				
		I				Steam Equipment	Pune	A				
		*				Flow Line Instrumant	Bangalore	DR				
		*				Instrumentation Limited	Kota	DR				
		*				Chemin Controls	Pondichery	DR				
121	SWAS Analyser (Chloride)	III				ABB	UK	A			Sub QR	
		III				Orion	USA	A				Orion Brand
		*				DKK	Japan	DR				
122	SWAS Analyser (Conductivity)	III				Hach	Switzerland	A			Sub QR	Polymetron Brand
		III				Emerson Process Management	Navi Mumbai	A				
		III				Yokogawa	Japan	A				
		III				ABB	UK	A				
		*				Honeywell	USA	DR				
		*				DKK	Japan	DR				
		*				Orion	USA	DR				
123	SWAS Analyser (Dissolved Oxygen)	III				Orion	USA	A			Sub QR	Orion Brand
		III				Hach	Switzerland	A				Polymetron Brand
		III				Emerson Process Management	USA	A				
		III				ABB	UK	A				
		*				Honeywell	USA	DR				
		*				DKK	Japan	DR				
124	SWAS Analyser (Hydrazine)	III				Hach	Switzerland	A			Sub QR	Polymetron Brand
		III				Orion	USA	A				Orion Brand
		III				ABB	UK	A				

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C&M Deptt. Patratu Vidyut Utpadan Nigam Limited ★ Distt-Ramgarh (Jharkhand)

NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR :BHEL Ltd	VENDOR AS APPROVED BY	DATE : 26.04.2017
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9585-001-QVIQ	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
		*				DKK	Japan	DR				
		*				Rosemount Analytical Inc Irvine		DR				
125	SWAS Analyser (pH)	III				ABB	UK	A			Sub QR	
		III				Hach	Switzerland	A				Polymetron Brand
		III				Emerson Process Management	Navi Mumbai	A				
		III				Yokogawa	Japan	A				
		*				Honeywell	USA	DR				
		*				DKK	Japan	DR				
		*				Orion		DR				
126	SWAS Analyser (Phosphate)	III				Hach	USA	A			Sub QR	
		III				Hach	Switzerland	A				Polymetron Brand
		III				ABB	UK	A				
		*				DKK	Japan	DR				
		*				Orion	USA	DR				
		*				Rosemount Analytical Inc Irvine		DR				
127	SWAS Analyser (Silica)	III				Hach	USA	A			Sub QR	
		III				Hach	Switzerland	A				Polymetron Brand
		III				ABB	UK	A				
		*				DKK	Japan	DR				
		*				Orion	USA	DR				
		*				Rosemount Analytical Inc Irvine		DR				
128	SWAS Analyser (Sodium)	III				Hach	Switzerland	A			Sub QR	Polymetron Brand
		III				Orion	USA	A				Orion Brand
		III				ABB	UK	A				
		*				DKK	Japan	DR				
129	SWAS Analyser (Turbidity)	III				ABB	UK	A			Sub QR	
		III				Emerson	USA	A				
		III				WTW	Germany	A				
		III				E & H	Germany	A				
		*				DKK	Japan	DR				
130	Operator Testing Simulator					Main Contractor will propose the vendors during detail Engineering.						
131	Concentration Analyser					Main Contractor will propose the vendors during detail Engineering.						
132	Electromagnetic Flow Meter	II				Krohne Marshal	Pune	A			Sub QR	
		II				E & H	Aurangabad	A				
		II				Emerson	Pawane	A				
		III				Yokogawa	Japan / China	DR				Only Ref list and catalouges to be submitted.
		III				SIEMENS	Germany	DR				
133	Fiber Optic Generator End winding VMS	II				Vibro System INC	Canada	A				
		II				MC-Monitoring SA	Switzerland	A				Note-6
134	H2 Gas Analyser Cabinet	II				ABB	Bangalore	A				H2 Gas Analyser Germany
		II				Adage Automation	Mumbai	A				H2 Gas Analyser siemens Germany Model Calomat-6
		II				Yokogawa	Bangalore	A				H2 Gas Analyser from yokogawa Japan
		II				Siemens	India	A				H2 Gas Analyser siemens Germany

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Bharat Heavy Electricals Limited ★ PS-MKTG Delhi

Adage Deptt.

NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACTOR :BHEL Ltd	VENDOR AS APPROVED BY	DATE : 26.04.2017
	CONTRACT NO : CS-9585-001-2		

No.	Major Equipment	QP Inspection Category	QP No. 9585-001-QVI-Q	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
135	Sight Flow Indicator	III				BHEL Approved Sources		A				
136	Amonia Analyser	*				Sick Maihak	Germany	DR				
		*				Emerson Process Management	Pawane	DR				
		*				Siemens	Germany	DR				
		*				Fuji Electric	Japan	DR				
		*				Thermofisher	Mumbai	DR				
		*				Yokogawa	Banglore	DR				
		*				Dongwoo Optron		DR				
137	AAQMS	I				Environment SA India Pvt. Ltd.	Bangalore	A			Sub QR	Analysers for Environment SA, France : Multipoint Calibrator from M/s L N Industrial, Switzerland and Metrological Sensors from M/s LSI Lastem SRL, Italy.
		I				Chemtrols	GOA	A				Analysers for Teledyne API, USA: Metrological Sensors & SPM from M/s Metone Instruments, USA.
		I				Thermo Electron LLS India PVt. Ltd.	Mumbai	A				Analysers for M/s Thermoenvironmental Instruments Inc., USA & Metrological Sensors from M/s Metone Instruments, USA.
		*				Land Combustion	UK	DR				
		*				Thermofisher	India / USA	DR				
138	EQMS	*				SEPL	Pune	DR			Sub QR	
		*				AICPL	Kota	DR				
		*				Nevco	Surat	DR				
		*				Thermofisher	Mumbai	DR				
		*				Themax	Pune	DR				
		*				Supreme Technology	Mumbai	DR				
139	RESIDUAL CHLORINE ANALYSER	III				E & H	GERMANY	A				
						EMERSON PROCESS	PAWANE	A				
						HACH	USA	A				
140	ORP ANALYZER	III				Emerson process	USA/Pawane	A				
						ABB	UK/USA	A				
						HACH	Switzerland	A				
						Yokogawa	Japan	A				
141	CL2 Leak detector	III				W&T	Germany	A				
142	Flame Scanner Cable	I				Thermocable	Hyderabad	A				
		I				Delton cables	Faridabad	A				

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Bharat Heavy Electricals Limited * PS-MKTG Delhi

Patratu Vidyut Utpadan Limited * Dist:Ramgarh(Jharkhand) * C & M Deptt.

NTPC	PROJECT : Patratu STPS Phase-I (3 X800MW)	LIST OF ITEMS REQUIRING QP	
	PACKAGE : EPC PACKAGE	APPROVAL & ACCEPTABLE	REVISION NO : 00
	CONTRACT NO : CS-9585-001-2	VENDOR AS APPROVED BY	DATE : 26.04.2017

No.	Major Equipment	QP Inspection Category	QP No. 9585-001-QVIQ	QP Submission SCH	QP Approval SCH	Proposed Sub Supplier	Country	SS Approval Status	SS Detail Sub.SCH	SS Approval SCH	Sub QR	Remark
		I				Cords Cable	Bhiwadi / Kaharani	A				

LEGENDS :

1.0 SYSTEM SUPPLIER / SUB SUPPLIER APPROVAL STATUS CATEGORY (SHALL BE FILLED BY NTPC)

A - For those items proposed vendor is acceptable to NTPC, subject to meeting the NTPC Specificaiton requirement. To be indicated with letter "A" in the list alognwith the condition of approval, if any.

DR - For those items "Detailed Required" for NTPC review. To be identified with letter "DR" in the list.

NOTED : For these items vendors are approved by Main Supplier and accepted by NTPC without specific vendor approval from NTPC. To be identified with "NOTED"

2.0 QP INSPECTION CATEGORY :
CAT - I : For those items the Quality Plans are approved by NTPC and final acceptance will be on physical inspection witness by NTPC
CAT - II : For those items the Quality Plans are approved by NTPC. However no physical inspection shall be done by NTPC. The final acceptance by NTPC shall be on the basis of review of documents.

CAT-III

UNITS/WORKS : Place of manufacturing. Place of main supplier of multi units/works.

* - Inspection category will be decided during vendor evaluation.

NOTE - 1 : EMPTY CABINETS, COMPUTERS, SIGNAL ISOLATOR/ MULTIPLIER, MCB, TB, POWER SUPPLY ETC. SHALL ALSO BE ACCEPTABLE FROM INDEGENEOUS SOURCES AGREED BY NTPC IN QP. IF THE TOTAL INTEGRATED PANEL AND FAT IS CONDUCTED INDEGENEOUSLY ITEM TO BE TREATED AS CAT - I.
NOTE - 2 : Mandatory Sapre will be treated as CAT-III
NOTE - 3 : For the items not appearing in the preaward list, bidder and NTPC will mutually discussed in future.

NOTE - 4 : Intergration testing of DDCMIS shall be done with monitor connected to the LVS workstation. This would be tied up in the QAP/ATST. Dispatch of LVS can be allowed like a CAT-III item but only after successful testing of funcaility as indiacted in QP and completion of ATST of first unit.

NOTE - 5 : C&I items intergral for skid,Fan, Motor,Pump etc instrument shall be supplied as per OEM standred/ approved sources.

NOTE - 6 : for instrumentation cable quantity less than 1 km of each type inspection category is III and for less then 2.5 km of each type inspection category is CAT-II

FORMAT NO. : QS-01-QAI-P-1/F3-R0

Engg. Div/QA&I

Bharat Heavy Electricals Limited PS-MKTG Delhi

Apadav.
AMIT YADAV
Mgr. MKTG.
BHEL

P.P. Patil
PRASHANT P. PATIL
Dy.M (QA-C&F)
26.07.26.

Bharat Heavy Electricals Limited C&M Deptt. Distt. Ramgarh (Jharkhand)

PACKAGE WISE REGISTERED SUPPLIER LIST (PERMANENT CATEGORY) AS ON 12/20/2018 12:46:42 PM

Sl No	Package Code	Package Name	Supplier Name	Supplier Communication Address	Supplier Works Address
1	145-03000-A	PROGRAMMABLE LOGIC CONTROLLER	GE Intelligent Platforms Private Limited	90/B, ELECTRONICS CITY, HOSUR ROAD, BANGLORE Phone- 28528328 Pincode : 561229 Email : shivesh.k.jha@ge.com	
2	145-03000-A	PROGRAMMABLE LOGIC CONTROLLER	SIEMENS LIMITED	Dr. Armin Bruck/Sandeep Mathur 130, Pandurang Budhkar Marg Worli Mumbai Phone- 0124 383 7377 Pincode : 400018 Email : ankit.varshney@siemens.com	Works-1->Ankit Varshney Kalwa Works, Thane-Belapur Road, Thane, -MUMBAI-MAHARASHTRA INDIA Phone- FAX : Pincode : 400708 Email :
3	145-03000-A	PROGRAMMABLE LOGIC CONTROLLER	MITSUBISHI ELECTRIC INDIA PVT. LTD.	Mr. Mehul Dholakia Emerald House, EL-3, J Block, M.I.D.C., Bhosari, Pune Phone- 020-27102000 Pincode : 411026 Email : mehul.dholakia@asia.meap.com	Works-1->Mr. Mehul Dholakia Others Emerald House, EL-3, J Block, M.I.D.C., Bhosari, -Pune-MAHARASHTRA INDIA Phone- 020-27102000 FAX : 020-27102100 Pincode : 411026 Email : mehul.dholakia@asia.meap.com
4	145-03000-A	PROGRAMMABLE LOGIC CONTROLLER	ROCKWELL AUTOMATION INDIA LTD	(ALLENBRADLEY),C-11, SITE-4, INDUSTRIAL AREA SHHIBABAD, GHAZIABAD Phone- 2895247-52 Pincode : 201010 Email : pmehrotra@rockwell.com	Works-1->Anup Sharma C-11 Site-4 Industrial Area,Sahibabad -Ghaziabad-UTTAR PRADESH India Phone- 0120-4017926 FAX : 0120-2895224 Pincode : 201010 Email : raindia@ra.rockwell.com
5	145-03000-A	PROGRAMMABLE LOGIC CONTROLLER	SCHNEIDER ELECTRIC INDIA PVT.LTD.	A-4 , MOHAN CO-OP INDL AREA MATHURA ROAD NEW DELHI Phone- Pincode : 110044 Email : aditya.bawa@schneider-electric.com	
6	145-03000-A	PROGRAMMABLE LOGIC CONTROLLER	Honeywell Automation India Limited ,	56 & 57, Hadapsar Industrial Estate, Pune, Phone- 9689940949, Pincode : Email : amit.aglave@honeywell.com,	Works-1-> 56 & 57, Hadapsar Industrial Estate, -Pune-MAHARASHTRA India Phone- 9689940949, FAX : 020-66039800, Pincode : Email : amit.aglave@honeywell.com
7	145-04000-A	CONTROL VALVE	SAMSON CONTROLS PVT. LTD.	Mr. Atul raje-MD D 281, MIDC Ranjangaon Ta Shirur Pune Phone- 02067246600 Pincode : 412220 Email : sales@samsoncontrols.net	Works-1-> Others D 281, MIDC Ranjangaon -Pune-MAHARASHTRA India Phone- 02067246600,8554997963 FAX : Pincode : 412220 Email : sales@samsoncontrols.net
8	145-04000-A	CONTROL VALVE	FORBES MARSHALL ARCA PVT.LTD.	A-34/35 , MIDC ESTATE, H-BLOCK, PIMPRI, PUNE, Phone- 020-27442020, Pincode : 411018 Email : mnadgaundi@forbesmarshall.com	Works-1->Mr. Sanjeev Shinde A-34/35 MIDC Estate,H Block, Pimpri, -Pune-MAHARASHTRA India Phone- 9323176406 FAX : 020-27442040 Pincode : 411018 Email : sshinde@forbesmarshall.com
9	145-04000-A	CONTROL VALVE	INSTRUMENTATION LTD.	KANJIKODE WEST, PALALKKAD, PALAKKAD Phone- 2566127-130,2567128 Pincode : 678623 Email : icvldil@gmail.com;fa2@ilpgt.com	Works-1->D.SASIDHARAN, AGM(Works&PPC) KANJIKODE WEST, -PALAKKAD-KERALA INDIA Phone- 0491-2566536 FAX : 0491-2566135 Pincode : 678623 Email : sasidharan@ilpgt.com
10	145-04000-A	CONTROL VALVE	Koso India Private Limited,	H 33 & 34, MIDC, Ambad, Nashik, Phone- 09650233433 Pincode : 422010, Email : jetmal.gour@koso.co.in	Works-1->P.J.ASHOK KUMAR/SEEMA ANAND Control Valve Division, H-33&34, MIDC, Ambad, -Nashik-MAHARASHTRA India Phone- 91 944 744 3198 FAX : 0491 - 5269914 Pincode : 422010 Email : pja@koso.co.in Works-2->+P.J.ASHOK KUMAR/SEEMA ANAND J-1,MIDC,Ambad -Nashik-MAHARASHTRA India Phone- 91 944 744 3198 FAX : 0491 - 5269914 Pincode : 422010 Email : pja@koso.co.in
11	145-04000-A	CONTROL VALVE	KSB MIL CONTROLS LTD.	Mr.Jacob Cherian/Mr.Geo Jolly Meladoor, Annamanada P.O. MALA, Thrissur Phone- 0480-2695700 Pincode : 680741 Email : biju.simon@ksb.com	Works-1->Mr.Biju Simon/Mr.Jose Paul Meladoor, Annamanada, -Thrissur-KERALA INDIA Phone- 9447555500 FAX : 91 480 2890952 Pincode : 680741 Email : jose.paul@ksb.com

PACKAGE WISE REGISTERED SUPPLIER LIST (PERMANENT CATEGORY) AS ON 12/20/2018 12:46:42 PM

Sl No	Package Code	Package Name	Supplier Name	Supplier Communication Address	Supplier Works Address
12	145-04000-A	CONTROL VALVE	SUZHOU DELAN ENERGY SCIENCE & TECHNOLOGY CO., LTD.	No 566 Fangqiao Road Caohu Industrial Park, Xiangcheng Economic Development Zone, Suzhou Phone- 008618012776062 Pincode : 215143 Email : jeanjelei@delan-valve.com	Works-1->Mr. Zong Xin CEO No 566 Fangqiao Road Caohu Industrial Park,Xiangcheng E. Z. -Suzhou-Foreign Country CHINA Phone- 008618012776062 FAX : Pincode : 215143 Email : jeanjelei@delan-valve.com
13	145-04000-A	CONTROL VALVE	R.K.CONTROL INSTRUMENTS PVT. LTD.	PLOT NO.A-250, OPP.POLICE STATION, WAGLE INDUSTRIAL ESTATE, THANE Phone- 25820943/2331 Pincode : 400604 Email : rkcipl@vsnl.com ; rkcinpvt@bol.net.in	Works-1->SAVITH KUMAR PLOT NO. A-250, OPP.POLICE STATION,WAGLE INDUSTRIAL ESTATE, THANE -THANE-MAHARASHTRA INDIA Phone- 022-'66060942 FAX : 022-25820801 Pincode : 400 604 Email : rkadmin@rkcipl.co.in
14	145-04000-A	CONTROL VALVE	Mascot Valves Pvt. Ltd.	166-167 GIDC Naroda Ahmedabad Phone- 0792282 1619 Pincode : 382330 Email : dom.sales@mascotvalves.com	Works-1->Varun Patel Dir 166-167 ,GIDC Naroda -Ahmedabad-GUJARAT India Phone- 0792282 1619 / 3369 FAX : Pincode : 382330 Email : dom.sales@mascotvalves.com
15	145-04000-A	CONTROL VALVE	Valvitalia S.P.A. ,	Mr. Salvatore Ruggeri Via Tortona 69, Rivanazzano (Pavia) Phone- +39-03839459875 Pincode : 27055 Email : dario.torluccio@valviatalia.com	Works-1->Mr. Salvatore Ruggeri Via Tortona 69,Rivanazzano (Pavia) -- Italy Phone- +39-03839459875 FAX : Pincode : 27055 Email : dario.torluccio@valviatalia.com; diego.poletti@valvitalia.com; sales@bhgassociates.com
16	145-04000-A	CONTROL VALVE	BOMAFA SPECIAL VALVE SOLUTIONS PVT LTD	Mr. K.M. Anklesaria/ R. M. Anklesaria Plot No: 285/2, Panchratna Estate, Near Ramol Bridge, Vatva Ahmedabad Phone- 079-40083825 Pincode : 382445 Email : info@bomafa-india.com	Works-1->Mr. K.M. Anklesaria/ Mr. R.M. Anklesaria Dir Plot No: 285/2, Panchratna Estate, Near Ramol Bridge, Vatva, -Ahmedabad-GUJARAT INDIA Phone- 079-40083825 FAX : Pincode : 382445 Email : info@bomafa-india.com
17	145-04000-A	CONTROL VALVE	DRESSER VALVE INDIA PVT. LTD	Mr. Raj Raman/Mr. Rajkumar Moria S.F. No: 608,Chettipalayam Road, Echanari Post, Coimbatore Phone- +91-98451 19085 Pincode : 641021 Email : Anoop.Ramachandran@ge.com	Works-1->Mr. Anoop Ramchandran S.F. No: 608,Chettipalayam Road, Echanari Post, -Coimbatore-TAMIL NADU INDIA Phone- +919500978296 FAX : +91 4223011200 Pincode : 641021 Email : Anoop.Ramachandran@ge.com
18	145-04000-A	CONTROL VALVE	Severn Glocon India Pvt. Ltd.	F96 & F97, Sipcot Industrial Park, Irungattukottai, Chennai, Phone- 044-47104200, Pincode : 602117, Email : info@severnglocon.co.in,	Works-1->Mr. K.Kaushik, F96 & F97, Sipcot Industrial Park,Irungattukottai, -Chennai-TAMIL NADU India Phone- 044-47104200, FAX : 044-47100073, Pincode : 602117, Email : info@severnglocon.co.in
19	145-04000-A	CONTROL VALVE	EMERSON PROCESS MANAGEMENT CHENNAI LIMITED	147, KARAPAKKAM VILLAGE, CHENNAI Phone- 23722184, 23716242 Pincode : 600096 Email : jatinder.singh@emerson.com	Works-1->Mr. Rangarajan (Head - Lean and Manufact 147,Karapakkam Village, -Chennai-TAMIL NADU India Phone- 0444903 4395 FAX : Pincode : 600097 Email : Rangarajan.M@emerson.com
20	145-04000-A	CONTROL VALVE	WALDEMAR PRUSS ARMATURENFABRIK GMBH	Mr. Winfried Dremhel Schulenburgerlandstrasse 261, Hannover Phone- +49-511279260 Pincode : 30419 Email : dremhel@pruss.de; vogel@pruss.de	Works-1->Mr. Winfried Dremhel CEO Schulenburgerlandstrasse 261, -Hannover-GERMANY Phone- +49-511279260 FAX : Pincode : 30419 Email : dremhel@pruss.de
21	145-06000-A	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	SWITZER PROCESS INSTRUMENTS PVT. LTD.	Mr. V S Jayaprakash, 128, SIDCO North Phase, Ambattur Estates CHENNAI Phone- 044-26252017/2018 Pincode : 600050 Email : sales@switzerprocess.co.in	Works-1->C S Shankar 127, Sidco North Phase, Ambattur Estates, -CHENNAI-TAMIL NADU INDIA Phone- 8754491904 FAX : 044-26248849 Pincode : 600050 Email : cservice@switzerinstrument.com

PACKAGE WISE REGISTERED SUPPLIER LIST (PERMANENT CATEGORY) AS ON 12/20/2018 12:46:42 PM

Sl No	Package Code	Package Name	Supplier Name	Supplier Communication Address	Supplier Works Address
22	145-06000-A	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	DRESSER INDUSTRIES INC.	Mr. Nishit Patel/Mr. Anuj Verma Plot No.2306, Phase II, GIDC Chhatral Kalol Phone- 02764-233682 Pincode : 382729 Email : Nishit.patel@ashcroftindia.com	
23	145-06000-A	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	Barksdale GmbH, Germany	Michael Weileder Dorn Assenheimer, Strasse 27 Reichelsheim Phone- +91-9999107840 Pincode : D-61203 Email : msingh@barksdale.de	
24	145-06000-A	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	GENERAL INSTRUMENTS CONSORTIUM	Mr. Amarendra Kulkarni 194/195, Gopi Tank Road, Off. Pandurang Naik Marg, Mahim Mumbai Phone- 9323195251 Pincode : 400016 Email : amarendra@general-gauges.com	
25	145-06000-A	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	PRECISION MASS PRODUCTS PVT. LTD.	Mr. Nishit Patel/Mr. Anuj Verma Plot No.2306, Phase II, GIDC Chhatral Kalol Phone- 9999464663 Pincode : 382729 Email : sales@precisionmass.com	Works-1->Mr. Hitesh Parmar/Mr. Hitesh Parmar Plot No.2306, Phase II, GIDC Chhatral, -Kalol-GUJARAT INDIA Phone- 9327359227 FAX : 02764-233440 Pincode : 382729 Email : hitesh.parmar@ashcroftindia.com
26	145-06000-A	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	INDFOS INDUSTRIES LIMITED	B-20-21, INDUSTRIAL AREA, MEERUT ROAD, GHAZIABAD Phone- 0120-2712016 Pincode : Email : mktg@indfos.com	
27	145-06000-A	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	SOR INC.	LARRY DEGARMO/Avdhesh Chandra, 14685 W. 105TH STREET LENEXA Phone- 09810905139, Pincode : 66215 Email : Ldegarmo@sorinc.com, avdhesh@sherman-india.com.	Works-1->LARRY DEGARMO/ ROY STUMBOUGH 14685 W. 105TH STREET, LENEXA -KANSAS- USA Phone- 913-888-0767 FAX : 913-888-0767 Pincode : 66215 Email : rstumbough@sorinc.com
28	145-06000-A	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	INDFOS (INDIA) LIMITED	MR.L.C.VENKATRANGAN/MR.B.KANNAN New No.17, II Floor, Adwave Towers, Dr.Sevalia Shivaji Salai, T.Nagar Chennai Phone- +91 44 24353407 Pincode : 600017 Email : delhi@indfos.com	
29	145-06000-A	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	Kaustubha Udyog,	S.No. 36/1/1, Sinhgad Road, Vadgaon Khurd, Near Lokmat Press, Pune, Phone- 020-24393577, Pincode : Email : pressure@vsnl.com.	
30	145-07000-A	ANALYTICAL INSTS.SAMPLE COOLER	SIEMENS LIMITED	Dr. Armin Bruck/Sandeep Mathur 130, Pandurang Budhkar Marg Worli Mumbai Phone- 0124 383 7377 Pincode : 400018 Email : ankit.varshney@siemens.com	Works-1->Ankit Varshney Kalwa Works, Thane-Belapur Road, Thane, -MUMBAI-MAHARASHTRA INDIA Phone- FAX : Pincode : 400708 Email :
31	145-07000-A	ANALYTICAL INSTS.SAMPLE COOLER	EMERSON PROCESS MANAGEMENT (INDIA) PVT.LTD.	Mr. Amit Paithankar/Vikram Raj Singh 206-210,BALARAMA BUILDING 2ND FLR. BANDRA EAST MUMBAI Phone- 9619121500 Pincode : 400051 Email : vikramraj.singh@emerson.com	Works-1->Kalpesh Chandan/Hrishikesh Aghor Plot No. A 145/4 TTC IND AREA,MIDC, PAWANE, -NAVI MUMBAI-MAHARASHTRA INDIA Phone- 9619688001 FAX : 022-66736000 Pincode : 400 705 Email : Kalpesh.chandan@emerson.com
32	145-07000-A	ANALYTICAL INSTS.SAMPLE COOLER	FORBES MARSHAL PVT. LTD.	A-33/34, MIDC ESTATE, H-BLOCK, PIMPRI, PUNE Phone- 27470171,27477472 Pincode : 411018 Email : nkaushal@forbesmarshall.com	

PACKAGE WISE REGISTERED SUPPLIER LIST (PERMANENT CATEGORY) AS ON 12/20/2018 12:46:42 PM

Sl No	Package Code	Package Name	Supplier Name	Supplier Communication Address	Supplier Works Address
33	145-08000-A	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	H.GURU INDUSTRIES	Mr. G. D. Hazra/Mr. P. K. Mitra 10 B, HO-CHI-MINH SARANI, KOLKATA Phone- 033 2282 2463 / 1637 Pincode : 700071 Email : mguru@vsnl.net	Works-1->NA NA -- Phone- FAX : Pincode : Email :
34	145-08000-A	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	BOSE PANDA INSTRUMENTS PVT.LTD.	Mr. Partha Bose 44, Saheed Hemanta Kumar Bose, Sarani, Kolkata Phone- +91 33 2548 7220 Pincode : 700074 Email : parthabosebpi@gmail.com; bosepanda@vsnl.net	Works-1->Mr. Partha Bose 44, Saheed Hemanta Kumar Bose,Sarani, -Kolkata-WEST BENGAL India Phone- +91 33 2548 7220 FAX : +91 33 2548 0429, Pincode : 700074 Email : parthabosebpi@gmail.com bosepanda@vsnl.net
35	145-08000-A	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	A.N. INSTRUMENTS PVT. LTD.	MARKETING DIVISION, 5th FLOOR, 59-B, CHOWRINGHEE ROAD, KOLKATA Phone- 24757784,22472509 Pincode : 700020 Email : anidel@bol.net.in	Works-1->Mr. Gautam Mukherjee Kusumba,Sonarpur Station Road,P.O. - Narendrapur, -Kolkata-WEST BENGAL INDIA Phone- 9836878855 FAX : 033-24342748 Pincode : 700103 Email : gkm_ani@hotmail.com
36	145-08000-A	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	PRECISION MASS PRODUCTS PVT. LTD.	Mr. Nishit Patel/Mr. Anuj Verma Plot No.2306, Phase II, GIDC Chhatral Kalol Phone- 9999464663 Pincode : 382729 Email : sales@precisionmass.com	Works-1->Mr. Hitesh Parmar/Mr. Hitesh Parmar Plot No.2306, Phase II, GIDC Chhatral, -Kalol-GUJARAT INDIA Phone- 9327359227 FAX : 02764-233440 Pincode : 382729 Email : hitesh.parmar@ashcroftindia.com
37	145-08000-A	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	H.GURU INSTRUMENTS (SOUTH INDIA) P. LTD	32,INDUSTRIAL SUBURB YESWANTHAPUR BANGALORE Phone- 080-23370300, Pincode : 560022 Email : info@hgurusouth.com	Works-1->Shikha Hazra/ Shyamal Hazra 32, Industrial Suburb,Yeshwanthpur - BANGALORE-KARNATAKA INDIA Phone- 080-23370300 FAX : 080-23379890 Pincode : 560022 Email : shikhahazra@hgurusouth.com
38	145-08000-A	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	Baumer Technologies India Pvt. Ltd.	Mr. Shyam Warilani/Mr. V Suresh Babu 36, DAMJI SHAMJI INDUSTRIAL COMPLEX, OFF.- MAHAKALI CAVES ROAD, ANDHERI(E) MUMBAI Phone- +91 99589 25151 Pincode : 400093 Email : sales.in@baumer.com	Works-1->Mr. Shyam Warilani/Mr. V Suresh Babu Plot No 34 À GIDC À Phase 1, -VAPI-GUJARAT INDIA Phone- +91 11 4161 7111 FAX : 022 2687 3613 Pincode : 396 195 Email : pbajaj@baumer.com
39	145-08000-A	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	FORBES MARSHALL (HYD) LTD.	MR SAILESH PATALAY/MR. M K SRINIVASAN PLOT NO.A-19/2, & T-4/2, IDA, NACHARAM, HYDERABAD Phone- 9849913704 Pincode : 500 076 Email : mksrinivasan@forbesmarshall.com	Works-1->MR G.SRINIVASAN/MR ANUJ MALPANI PLOT NO:A-19/2 & T-4/2,I.DA. NACHARAM , -HYDERABAD-TELANGANA INDIA Phone- 09866550762 FAX : 040 27152193 Pincode : 560076 Email : gshrinivasan@forbesmarshall.com
40	145-08000-A	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	GAUGE BOURDON INDIA PVT. LTD.	194/195, Gopi Tank Road, Off Pandurang Naik Marg, Mahim Mumbai, Phone- 011-41607463, Pincode : 400016, Email : gicdelhi@general-gauges.com,	Works-1->Gauge Bourdon India Pvt. Ltd., Plot No-4, 5, 6,Jawahar Co-operative Industrial Estate, -Kalamboli Taluka Panvel-MAHARASHTRA India Phone- 022-27421095, FAX : 022-27421901, Pincode : 410209, Email : info@general-gauges.com
41	145-08000-A	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	Nesstech Instruments Private Limited	26/2, G Type, Global Industrial Park Near Nahuli Railway Crossing, Valvada Vapi Phone- 9920576002 Pincode : 396105 Email : sales@nesstech.co.in	Works-1-> Others 26/2, G Type, Global Ind. Park Near Nahuli Railway Crossing, -Vapi-GUJARAT INDIA Phone- 9920576002 FAX : Pincode : 396105 Email : sales@nesstech.co.in, bkapadia@nesstech.co.in

PACKAGE WISE REGISTERED SUPPLIER LIST (PERMANENT CATEGORY) AS ON 12/20/2018 12:46:42 PM

Sl No	Package Code	Package Name	Supplier Name	Supplier Communication Address	Supplier Works Address
42	145-08000-A	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	Office no. 53, Shree Manoshi Complex, Plot No. 5 & 6, Sec-3, Ghansoli (East), Navi Mumbai, Phone- 9892230623, Pincode : 400 701, Email : sdbpl@vsnl.com	Works-1->Scientific Center, Others By-Pass Junction,Near Kalsekar College kausa, mumbra,Thane -Mumbai-MAHARASHTRA INDIA Phone- 022-25491409,9892230623 FAX : Pincode : 400612 Email : sdbpl@vsnl.com
43	145-10000-A	TEMPERATURE GAUGE	GOA INSTRUMENTS INDUSTRIES PVT.LTD.,	D2/5, Mapusa Industrial Estate, Mapusa, Goa, Phone- 09326054551, Pincode : 403507, Email : sumukh@goainstruments.com,	Works-1->Mr. S.G. Dixit D2/5, Mapusa Industrial Estate, -Mapusa-GOA INDIA Phone- 09326054551 FAX : 0832-2262331 Pincode : 403 507 Email : sumukh@goainstruments.com
44	145-10000-A	TEMPERATURE GAUGE	FORBES MARSHALL (HYD) LTD.	MR SAILESH PATALAY/MR. M K SRINIVASAN PLOT NO.A-19/2, & T-4/2, IDA, NACHARAM, HYDERABAD Phone- 9849913704 Pincode : 500 076 Email : mksrinivasan@forbesmarshall.com	Works-1->MR G.SRINIVASAN/MR ANUJ MALPANI PLOT NO:A-19/2 & T-4/2,I.DA. NACHARAM , -HYDERABAD-TELANGANA INDIA Phone- 09866550762 FAX : 040 27152193 Pincode : 560076 Email : gshrinivasan@forbesmarshall.com
45	145-10000-A	TEMPERATURE GAUGE	H.GURU INSTRUMENTS (SOUTH INDIA) P. LTD	32,INDUSTRIAL SUBURB YESWANTHAPUR BANGALORE Phone- 080-23370300, Pincode : 560022 Email : info@hgurusouth.com	Works-1->Shikha Hazra/ Shyamal Hazra 32, Industrial Suburb,Yeshwanthpur - BANGALORE-KARNATAKA INDIA Phone- 080-23370300 FAX : 080-23379890 Pincode : 560022 Email : shikhahazra@hgurusouth.com
46	145-10000-A	TEMPERATURE GAUGE	GAUGE BOURDON INDIA PVT. LTD.	194/195, Gopi Tank Road, Off Pandurang Naik Marg, Mahim Mumbai, Phone- 011-41607463, Pincode : 400016, Email : gicdelhi@general-gauges.com,	Works-1->Gauge Bourdon India Pvt. Ltd., Plot No-4, 5, 6,Jawahar Co-operative Industrial Estate, -Kalamboli Taluka Panvel-MAHARASHTRA India Phone- 022-27421095, FAX : 022-27421901, Pincode : 410209, Email : info@general-gauges.com
47	145-10000-A	TEMPERATURE GAUGE	H.GURU INDUSTRIES	Mr. G. D. Hazra/Mr. P. K. Mitra 10 B, HO-CHI-MINH SARANI, KOLKATA Phone- 033 2282 2463 / 1637 Pincode : 700071 Email : mguru@vsnl.net	Works-1->NA NA -- Phone- FAX : Pincode : Email :
48	145-10000-A	TEMPERATURE GAUGE	GOA THERMOSTATIC INSTRUMENTS PVT.LTD.	FLAT -B , GF, HILL CROWN APTS., COLLEGE ROAD, MAPUSA Phone- Pincode : 403525 Email : gtilworks@pyro-electric.in	Works-1->Mrs Saanvi Naik BICHOLIM, -BICHOLIM-GOA INDIA Phone- 9595855152 FAX : Pincode : 403 529 Email : saanvi.naik@thermostatic.in
49	145-10000-A	TEMPERATURE GAUGE	A.N. INSTRUMENTS PVT. LTD.	MARKETING DIVISION, 5th FLOOR, 59-B, CHOWRINGHEE ROAD, KOLKATA Phone- 24757784,22472509 Pincode : 700020 Email : anidel@bol.net.in	Works-1->Mr. Gautam Mukherjee Kusumba,Sonarpur Station Road,P.O. - Narendrapur, -Kolkata-WEST BENGAL INDIA Phone- 9836878855 FAX : 033-24342748 Pincode : 700103 Email : gkm_ani@hotmail.com
50	145-10000-A	TEMPERATURE GAUGE	Baumer Technologies India Pvt. Ltd.	Mr. Shyam Warilani/Mr. V Suresh Babu 36, DAMJI SHAMJI INDUSTRIAL COMPLEX, OFF.-MAHAKALI CAVES ROAD, ANDHERI(E) MUMBAI Phone- +91 99589 25151 Pincode : 400093 Email : sales.in@baumer.com	Works-1->Mr. Shyam Warilani/Mr. V Suresh Babu Plot No 34 À GIDC À Phase 1, -VAPI-GUJARAT INDIA Phone- +91 11 4161 7111 FAX : 022 2687 3613 Pincode : 396 195 Email : pbajaj@baumer.com
51	145-10000-A	TEMPERATURE GAUGE	PRECISION MASS PRODUCTS PVT. LTD.	Mr. Nishit Patel/Mr. Anuj Verma Plot No.2306, Phase II, GIDC Chhatral Kalol Phone- 9999464663 Pincode : 382729 Email : sales@precisionmass.com	Works-1->Mr. Hitesh Parmar/Mr. Hitesh Parmar Plot No.2306, Phase II, GIDC Chhatral, -Kalol-GUJARAT INDIA Phone- 9327359227 FAX : 02764-233440 Pincode : 382729 Email : hitesh.parmar@ashcroftindia.com

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Sl No	Package Code	Package Name	Supplier Name	Supplier Communication Address	Supplier Works Address
52	145-11000-A	LEVEL GAUGE	TOSHNIWAL BROTHERS PVT.LTD.	WORKS:TOSHNIWAL IND.PVT.LTD, INDUSTRIAL ESTATE MAKHUPURA, AJMER Phone- 441171 Pincode : 305002 Email : toshniwalprocess@gmail.com	
53	145-11000-A	LEVEL GAUGE	SIGMA INSTRUMENTS CO.	Gopal Kannan/R Gopinath 201, ANANDRAJ INDUSTRIAL ESTATE, OFF.LBS MARG, SONAPUR LANE, BHANDUP (W) MUMBAI Phone- +919821038162 Pincode : 400078 Email : sales@sigmainstruments.co.in	Works-1->R Gopinath 27 Nahur Udyog Industrial Premises,M.M.Malviya Road, Mulund(-MUMBAI-MAHARASHTRA INDIA Phone- +912225918567 FAX : +912225918566 Pincode : 400080 Email : sales@sigmainstruments.co.in
54	145-11000-A	LEVEL GAUGE	BLISS ANAND PVT. LTD.	Mr. Vikas Anand/ Mr.RGRajan 92B & 93 B , IMT MANESAR Gurgaon Phone- 0124-4366000 TO 9 Pincode : 122001 Email : sales@blissanand.com	Works-1->Mr. Bharat Kumar/ Mr. Sasi Kumar Plot No. 92B & 93B,Sec-V, IMTManesar -GURGAON-HARYANA INDIA Phone- 0124-4366000 TO 9 FAX : 0124-2290884 Pincode : 122002 Email : bharat@blissanand .com
55	145-12000-A	FLOW ELEMENT	MICRO PRECISION PRODUCTS PVT. LTD.	Mr. SANJEEV CHAUHAN H.B. No.-40, Revenue Estate, Village-Dudhola,Tehsil & Distt. Palwal FARIDABAD Phone- 9871620282 Pincode : 121002 Email : Sanjeev.Chauhan@micro-precision.co.in	
56	145-12000-A	FLOW ELEMENT	STAR-MECH CONTROLS (I) PVT.LTD.	SUSHILLOTAM, SUSHILLOTAM, 29/3A/3, SASANE NAGAR, HADAPSAR, PUNE Phone- 02026970450 Pincode : 411028 Email : marketing@starmech.net	Works-1->VlVEK GOTE/ MAHúNDRA BANSODE Sr no.54, Plot No.ll0,Swami ViVekanand Industrial Est.HADAPS -PUNE-MAHARASHTRA INDIA Phone- 02026970450 FAX : 02026970470 Pincode : 411028 Email : marketing@starmech.net
57	145-12000-A	FLOW ELEMENT	INSTRUMENTATION LTD.	KANJIKODE WEST, PALALKKAD, PALAKKAD Phone- 2566127-130,2567128 Pincode : 678623 Email : icvldil@gmail.com;fa2@ilpgt.com	
58	145-12000-A	FLOW ELEMENT	TM TECNOMATIC SPA	MR. ANTONIO NOVIELLO/Mrs. Enrica Bazzocc VIA DELLE INDUSTRIE, 36 CREMONA Phone- 39037221574 Pincode : 26100 Email : info@tmtecnomatic.com	Works-1->Mrs. Enrica Bazzocchi VIA DELLE INDUSTRIE, 36, -CREMONA- Italy Phone- 39037221574 FAX : 39037228318 Pincode : 26100 Email : sales@tmtecnomatic.com
59	145-13000-A	TEMP. ELEMENT	PYRO ELECTRIC INSTRUMENTS GOA PVT.LTD.	M. D. BICHU/R. M. BICHU G.B, HILL CROWN APARTMENTS, COLLEGE ROAD, MAPUSA Phone- 9326114601 Pincode : 403507 Email : priyanka.marketing@pyro-electric.in	Works-1->A A KULKARNI/ VINOD C G PLOT NO. 71,BICHOLIM INDUSTRIAL ESTATE -BICHOLIM-GOA INDIA Phone- 9326114409 FAX : 91 832 2363381 Pincode : 403529 Email : pyroworks@pyro-electric.in
60	145-13000-A	TEMP. ELEMENT	Baumer Technologies India Pvt. Ltd.	Mr. Shyam Warilani/Mr. V Suresh Babu 36, DAMJI SHAMJI INDUSTRIAL COMPLEX, OFF.-MAHAKALI CAVES ROAD, ANDHERI(E) MUMBAI Phone- +91 99589 25151 Pincode : 400093 Email : sales.in@baumer.com	Works-1->Mr. Shyam Warilani/Mr. V Suresh Babu Plot No 34 À GIDC À Phase 1, -VAPI-GUJARAT INDIA Phone- +91 11 4161 7111 FAX : 022 2687 3613 Pincode : 396 195 Email : pbajaj@baumer.com
61	145-13000-A	TEMP. ELEMENT	DETRIVE INSTRUMENTATION & ELECTRONICS LTD.	320, TV INDUSTIAL ESTATE, OFF.DR.A.BESANT ROAD, BEHIND GLAXO, WORLI, MUMBAI Phone- 24934125,24938403 Pincode : 400025 Email : trivtech@vsnl.com	Works-1->Mr. A.D.Solomon J-14, MIDC, TARAPORE, BOISER STN., -THANE-MAHARASHTRA India Phone- FAX : Pincode : Email : trivtech@vsnl.com

PACKAGE WISE REGISTERED SUPPLIER LIST (PERMANENT CATEGORY) AS ON 12/20/2018 12:46:42 PM

Sl No	Package Code	Package Name	Supplier Name	Supplier Communication Address	Supplier Works Address
62	145-13000-A	TEMP. ELEMENT	Nesstech Instruments Private Limited	26/2, G Type, Global Industrial Park Near Nahuli Railway Crossing, Valvada Vapi Phone- 9920576002 Pincode : 396105 Email : sales@nesstech.co.in	Works-1-> Others 26/2, G Type, Global Ind. Park Near Nahuli Railway Crossing, -Vapi-GUJARAT INDIA Phone- 9920576002 FAX : Pincode : 396105 Email : sales@nesstech.co.in, bkapadia@nesstech.co.in
63	145-13000-A	TEMP. ELEMENT	Thermal Instrument India Pvt. Ltd.	Mr. Raghavendra M. Kulkarni 194/195, Gopi Tank Road Behind Citylight Cinema,Mahim Mumbai Phone- 09322664709 Pincode : 400016 Email : ramk@giconindia.com	Works-1->Mr. Raghavendra M. Kulkarni Survey No. 250A/B, Post-Mangaon,Tal.-Kudal, Dist.- Sindhudurg, --MAHARASHTRA India Phone- 09322664709 FAX : 022-24455026 Pincode : 416519 Email : ramk@giconindia.com
64	145-13000-A	TEMP. ELEMENT	GAUGE BOURDON INDIA PVT. LTD.	194/195, Gopi Tank Road, Off Pandurang Naik Marg, Mahim Mumbai, Phone- 011-41607463, Pincode : 400016, Email : gicdelhi@general-gauges.com,	Works-1->Gauge Bourdon India Pvt. Ltd., Plot No-4, 5, 6,Jawahar Co-operative Industrial Estate, -Kalamboli Taluka Panvel-MAHARASHTRA India Phone- 022-27421095, FAX : 022-27421901, Pincode : 410209, Email : info@general-gauges.com
65	145-13000-A	TEMP. ELEMENT	GOA INSTRUMENTS INDUSTRIES PVT.LTD.,	D2/5, Mapusa Industrial Estate, Mapusa, Goa, Phone- 09326054551, Pincode : 403507, Email : sumukh@goainstruments.com,	Works-1->Mr. S.G. Dixit D2/5, Mapusa Industrial Estate, -Mapusa-GOA INDIA Phone- 09326054551 FAX : 0832-2262331 Pincode : 403 507 Email : sumukh@goainstruments.com
66	145-13000-A	TEMP. ELEMENT	TOSHNIWAL INDUSTRIES PVT. LTD.,	Industrial Estate, Makhupura, Ajmer, Phone- 9352009000, Pincode : 305002, Email : info@tipl.com,	Works-1-> Khasra No.: 218-230& 235, Industrial Estate,Makhupura, -Ajmer-RAJASTHAN India Phone- 9887865856, FAX : 0145-2695174, Pincode : 305002, Email : rajeev.gupta@tipl.com
67	145-13000-A	TEMP. ELEMENT	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	Office no. 53, Shree Manoshi Complex, Plot No. 5 & 6, Sec-3, Ghansoli (East), Navi Mumbai, Phone- 9892230623, Pincode : 400 701, Email : sdbpl@vsnl.com	Works-1->Scientific Center, Others By-Pass Junction,Near Kalsekar College kausa, mumbra,Thane -Mumbai-MAHARASHTRA INDIA Phone- 022-25491409,9892230623 FAX : Pincode : 400612 Email : sdbpl@vsnl.com
68	145-13000-A	TEMP. ELEMENT	Tempsens Instrument (I) Pvt Ltd	MR. V.P.RATHI/MR. HEMANT RATHI B-188A ROAD NO.5 , M.I.A UDAIPUR Phone- 09352420069 Pincode : 313003 Email : info@tempsens.com	Works-1->Mr. S.D Deval B-188A ROAD NO.5 ,M.I.A -UDAIPUR-RAJASTHAN INDIA Phone- 9352501530 FAX : 0294-3057750 Pincode : 313003 Email : deval@tempsens.com
69	145-14000-A	TRANSMITTERS	YOKOGAWA INDIA LIMITED,	PLOT NO.96, ELECTRONICS CITY COMPLEX, HOSUR ROAD, BANGALORE, Phone- 080-41586000, Pincode : Email : uday.shankar@in.yokogawa.com,	Works-1-> PLOT NO.96, ELECTRONICS CITY COMPLEX, HOSUR ROAD, -BANGALORE-KARNATAKA INDIA Phone- 080-41586000, FAX : 080-28521442, Pincode : Email : uday.shankar@in.yokogawa.com
70	145-14000-A	TRANSMITTERS	V. AUTOMAT & INTRUMENTS (P) LTD.	Mr. R. K. BASSI/Mr. PRAVEEN KUMAR F-61, OKHLA INDL.AREA, PH-1 NEW DELHI Phone- 9810005826 Pincode : 110 020 Email : sales@vautomat.com	Works-1->Mr. BHAGWAN SINGH/ Mr. NANDAN SINGH F-61, OKHLA INDL.AREA,PHASE-I -NEW DELHI-DELHI INDIA Phone- 011-47627200 Extn. 3 FAX : 011- 26819440 Pincode : 110 020 Email : production@vautomat.com
71	145-14000-A	TRANSMITTERS	Pune Techtrol Pvt. Ltd.	N.P.Khatan/Sudhakar Badiger S-18, MIDC Bhosari, Pune Phone- 9850560042 Pincode : 411 026 Email : ho@punetechtrol.com	
72	145-14000-A	TRANSMITTERS	ABB INDIA LIMITED	MR. RAJIV GOVIL 14, MATHURA ROAD, FARIDABAD Phone- 09971085678 Pincode : 121003 Email : vipin.swami@in.abb.com	

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Sl No	Package Code	Package Name	Supplier Name	Supplier Communication Address	Supplier Works Address
73	145-14000-A	TRANSMITTERS	TOSHNIWAL INDUSTRIES PVT. LTD.,	Industrial Estate, Makhupura, Ajmer, Phone- 9352009000, Pincode : 305002, Email : info@tipl.com,	Works-1-> Khasra No.: 218-230& 235, Industrial Estate,Makhupura, -Ajmer-RAJASTHAN India Phone- 9887865856, FAX : 0145-2695174, Pincode : 305002, Email : rajeev.gupta@tipl.com
74	145-14000-A	TRANSMITTERS	SBEM PVT. LTD.	MR.N.K. BEDARKAR/MR. VISHWANATH KARANDIK 39, ELECTRONIC CO.OP. ESTATE, PUNE SATARA ROAD PUNE, Phone- 912041030100 Pincode : 411009 Email : newdelhi@sbem.co.in	Works-1->MR. MOHAN PADWAL 691/A/2,BIBWEWADI INDL ESTATE -PUNE-MAHARASHTRA INDIA Phone- 918600042374 FAX : 912024215670 Pincode : 411037 Email : wm@sbem.co.in
75	145-14000-A	TRANSMITTERS	Endress + Hauser (India) Pvt. Ltd.,	Mr. Prakash Vaghela 215-216, DLF Tower 'A', Jasola District Centre, New Delhi, Phone- 9717593001, Pincode : 110025, Email : prakash.vaghela@in.endress.com,	Works-1-> M-171 to 173, MIDC, Waluj, -Aurangabad-MAHARASHTRA India Phone- 9881000474, FAX : 0240-2555179, Pincode : 431136, Email : Narendra.Kulkarni@wetzer.endress.com
76	145-14000-A	TRANSMITTERS	Moore Industries International Inc.	Leonard.W. Moore/ Matt Moren 16650 Schoenborn St. North Hills Phone- +1 818 830 5548 Pincode : 91343 Email : mmoren@miinet.com	Works-1->Matt Moren/Gina Cruz 16650 Schoenborn St., North Hills -CALIFORNIA-USA Phone- +1 818 894 7111, ext FAX : +1 818 830 5588 Pincode : 91343 Email : gcruz@miinet.com
77	145-14000-A	TRANSMITTERS	PANAM ENGINEERS	Mr. Santosh Shukla 203, Jaisingh Business,Parsiwada, Sahar road,Andheri(East), Mumbai, Phone- 9892179529, Pincode : 400099, Email : santosh@panamengineers.com,	Works-1->Mr. Santosh Shukla Others R-628,TTC Industrial Area, MIDC Rabale, -Navi Mumbai-MAHARASHTRA India Phone- 9821350761, FAX : 022-27695559, Pincode : 400701, Email : sales@panamengineers.com
78	145-14000-A	TRANSMITTERS	Honeywell Automation India Limited	Mr. Ritwij Kulkarni 917, INTERNATIONAL TRADE TOWER, NEHRU PLACE, NEW DELHI Phone- 9890200584 Pincode : 110019 Email : rajesh.chaudhary@honeywell.com	Works-1->Mr.Kedar Tillu 53, 54, 56 & 57,Hadapsar Industrial Estate -PUNE-MAHARASHTRA INDIA Phone- 9665034625 FAX : 020 66039905 Pincode : 411013 Email : kedar.tillu@honeywell.com
79	145-14000-A	TRANSMITTERS	EMERSON PROCESS MANAGEMENT (INDIA) PVT.LTD.	Mr. Amit Paithankar/Vikram Raj Singh 206-210,BALARAMA BUILDING 2ND FLR. BANDRA EAST MUMBAI Phone- 9619121500 Pincode : 400051 Email : vikramraj.singh@emerson.com	Works-1->Kalpesh Chandan/Hrishikesh Aghor Plot No. A 145/4 TTC IND AREA,MIDC, PAWANE, -NAVI MUMBAI-MAHARASHTRA INDIA Phone- 9619688001 FAX : 022-66736000 Pincode : 400 705 Email : Kalpesh.chandan@emerson.com
80	145-14000-A	TRANSMITTERS	SMART INSTRUMENTS LTD, BRAZIL	Agents: Digital Electronic Ltd. 74/11 'C' Cross Road MIDC Andheri (East) MUMBAI Phone- 28208477 Pincode : 400093 Email : corp@delbby.rpgms.ems.vsnl.net.in	
81	145-14000-A	TRANSMITTERS	SIEMENS LIMITED	Dr. Armin Bruck/Sandeep Mathur 130, Pandurang Budhkar Marg Worli Mumbai Phone- 0124 383 7377 Pincode : 400018 Email : ankit.varshney@siemens.com	Works-1->Ankit Varshney Kalwa Works, Thane-Belapur Road, Thane, -MUMBAI-MAHARASHTRA INDIA Phone- FAX : Pincode : 400708 Email :
82	145-14000-A	TRANSMITTERS	NIVO CONTROLS PVT. LTD.	Mr. Praveen Toshniwal 104-115, Electronic Complex, Indore Phone- 0731-4081305 Pincode : 452010 Email : sales@nivocontrols.com	Works-1->Mr. Praveen Toshniwal 104-115, Electronic Complex, -Indore-MADHYA PRADESH India Phone- 0731-4081305 FAX : 0731-255075 Pincode : 452010 Email : sales@nivocontrols.com

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Sl No	Package Code	Package Name	Supplier Name	Supplier Communication Address	Supplier Works Address
83	145-15000-A	TEMPERATURE SWITCH	SOR INC.	LARRY DEGARMO/Avdhesh Chandra, 14685 W. 105TH STREET LENEXA Phone- 09810905139, Pincode : 66215 Email : Ldegarmo@sorinc.com, avdhesh@sherman-india.com,	Works-1->LARRY DEGARMO/ ROY STUMBOUGH 14685 W. 105TH STREET, LENEXA -KANSAS- USA Phone- 913-888-0767 FAX : 913-888-0767 Pincode : 66215 Email : rstumbough@sorinc.com
84	145-15000-A	TEMPERATURE SWITCH	TOSHNIWAL BROTHERS PVT.LTD.	WORKS:TOSHNIWAL IND.PVT.LTD, INDUSTRIAL ESTATE MAKHUPURA, AJMER Phone- 441171 Pincode : 305002 Email : toshniwalprocess@gmail.com	
85	145-15000-A	TEMPERATURE SWITCH	DRESSER INDUSTRIES INC.	Mr. Nishit Patel/Mr. Anuj Verma Plot No.2306, Phase II, GIDC Chhatral Kalol Phone- 02764-233682 Pincode : 382729 Email : Nishit.patel@ashcroftindia.com	
86	145-15000-A	TEMPERATURE SWITCH	INDFOS (INDIA) LIMITED	MR.L.C.VENKATRANGAN/MR.B.KANNAN New No.17, II Floor, Adwave Towers, Dr.Sevalia Shivaji Salai, T.Nagar Chennai Phone- +91 44 24353407 Pincode : 600017 Email : delhi@indfos.com	
87	145-15000-A	TEMPERATURE SWITCH	SWITZER PROCESS INSTRUMENTS PVT. LTD.	Mr. V S Jayaprakash, 128, SIDCO North Phase, Ambattur Estates CHENNAI Phone- 044-26252017/2018 Pincode : 600050 Email : sales@switzerprocess.co.in	Works-1->C S Shankar 127, Sidco North Phase, Ambattur Estates, -CHENNAI-TAMIL NADU INDIA Phone- 8754491904 FAX : 044-26248849 Pincode : 600050 Email : cservice@switzerinstrument.com
88	145-16000-A	SIGHT FLOW INDICATORS	V. AUTOMAT & INTRUMENTS (P) LTD.	Mr. R. K. BASSI/Mr. PRAVEEN KUMAR F-61, OKHLA INDL.AREA, PH-1 NEW DELHI Phone- 9810005826 Pincode : 110 020 Email : sales@vautomat.com	Works-1->Mr. BHAGWAN SINGH/ Mr. NANDAN SINGH F-34, OKHLA INDL.AREA,PHASE-I -NEW DELHI-DELHI INDIA Phone- 011-47627200 Extn. 3 FAX : 011- 26819440 Pincode : 110 020 Email : production@vautomat.com
89	145-16000-A	SIGHT FLOW INDICATORS	BLISS ANAND PVT. LTD.	Mr. Vikas Anand/ Mr.RGRajan 92B & 93 B , IMT MANESAR Gurgaon Phone- 0124-4366000 TO 9 Pincode : 122001 Email : sales@blissanand.com	Works-1->Mr. Bharat Kumar/ Mr. Sasi Kumar Plot No. 240, Sector-3, HSIIDC, Bawal -Rewari-HARYANA INDIA Phone- 0124-4366000 TO 9 FAX : 0124-2290884 Pincode : 123501 Email : bharat@blissanand .com
90	145-16000-A	SIGHT FLOW INDICATORS	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	Office no. 53, Shree Manoshi Complex, Plot No. 5 & 6, Sec-3, Ghansoli (East), Navi Mumbai, Phone- 9892230623, Pincode : 400 701, Email : sdbpl@vsnl.com	
91	145-16000-A	SIGHT FLOW INDICATORS	B.K.EQUIPMENTS PVT.LTD.	T. BALAKRISHNAN/S.VENKATESH 217 , ARCOT ROAD PORUR , CHENNAI Phone- 9444057761 Pincode : 600116 Email : bkequip@gmail.com	Works-1->V.KARUNANIDHI/P.BABU 217 , ARCOT ROAD,PORUR , -CHENNAI-TAMIL NADU INDIA Phone- 9444131187 FAX : 044-24766852 Pincode : 600116 Email : bkequip@gmail.com
92	145-16000-A	SIGHT FLOW INDICATORS	SIGMA INSTRUMENTS CO.	Gopal Kannan/R Gopinath 201, ANANDRAJ INDUSTRIAL ESTATE, OFF.LBS MARG, SONAPUR LANE, BHANDUP (W) MUMBAI Phone- +919821038162 Pincode : 400078 Email : sales@sigmainstruments.co.in	Works-1->R Gopinath 27 Nahur Udyog Industrial Premises,M.M.Malviya Road, Mulund(-MUMBAI-MAHARASHTRA INDIA Phone- +912225918567 FAX : +912225918566 Pincode : 400080 Email : sales@sigmainstruments.co.in

PACKAGE WISE REGISTERED SUPPLIER LIST (PERMANENT CATEGORY) AS ON 12/20/2018 12:46:42 PM

Sl No	Package Code	Package Name	Supplier Name	Supplier Communication Address	Supplier Works Address
93	145-16000-A	SIGHT FLOW INDICATORS	INSTRUMENTATION ENGINEERS PVT LTD	SH.N.V.RAM GOPAL/MS. N.NIHARIKA PLOTS 1,2,3, PHASE-III, IDA, JEEDIMETLA HYDERABAD Phone- 9848407365 Pincode : 500055 Email : iedelhi@ieflowmeters.com	Works-1->MR. A.V.MURTHY/MR. K.T. RAVISANKER PLOTS 1,2,3, PHASE-III,IDA, JEEDIMETLA -HYDERABAD-TELANGANA INDIA Phone- 9885107312 FAX : 040-23096401 Pincode : 500055 Email : sales@ieflowmeters.com
94	145-21000-A	DIFFERENTIAL PRESSURE SWITCH	SOR INC.	LARRY DEGARMO/Avdhesh Chandra, 14685 W. 105TH STREET LENEXA Phone- 09810905139, Pincode : 66215 Email : Ldegarmo@sorinc.com, avdhesh@sherman-india.com,	
95	145-23000-A	ANUBAR (DELTA TUBE)	STAR-MECH CONTROLS (I) PVT.LTD.	SUSHILLOTAM, SUSHILLOTAM, 29/3A/3, SASANE NAGAR, HADAPSAR, PUNE Phone- 02026970450 Pincode : 411028 Email : marketing@starmech.net	Works-1->VlVEK GOTE/ MAHúNDRA BANSODE Sr no.54, Plot No.ll0,Swami ViVekanand Industrial Est.HADAPS -PUNE-MAHARASHTRA INDIA Phone- 02026970450 FAX : 02026970470 Pincode : 411028 Email : marketing@starmech.net
96	145-23000-A	ANUBAR (DELTA TUBE)	TM TECNOMATIC SPA	MR. ANTONIO NOVIELLO/Mrs. Enrica Bazzocc VIA DELLE INDUSTRIE, 36 CREMONA Phone- 39037221574 Pincode : 26100 Email : info@tmtecnomatic.com	Works-1->Mrs. Enrica Bazzocchi VIA DELLE INDUSTRIE, 36, -CREMONA- Italy Phone- 39037221574 FAX : 39037228318 Pincode : 26100 Email : sales@tmtecnomatic.com
97	145-23000-A	ANUBAR (DELTA TUBE)	DYNAFLUID VALVES AND FLOW CONTROLS (P) LTD.	Mr. Yogish M. Kulkarni Plot # 23, Udyambag, Belgaum Phone- 0831-4210386 Pincode : 590008 Email : yogish@dyna-fluid.com	Works-1->Mr. Yogish M. Kulkarni Dir Plot # 23, Udyambag, -Belgaum-KARNATAKA INDIA Phone- 0831-4210386 FAX : 0831-4210386 Pincode : 590008 Email : yogish@dyna-fluid.com
98	145-23000-A	ANUBAR (DELTA TUBE)	MICRO PRECISION PRODUCTS PVT. LTD.	Mr. SANJEEV CHAUHAN H.B. No.-40, Revenue Estate, Village-Dudhola,Tehsil & Distt. Palwal FARIDABAD Phone- 9871620282 Pincode : 121002 Email : Sanjeev.Chauhan@micro-precision.co.in	Works-1->Mr. SANJEEV CHAUHAN ,H.B. No.-40 Others Revenue Estate, Village-Dudhola, Tehsil & Distt.-Palwal -Faridabad-Haryana India Phone- 9871620282 FAX : Pincode : 121002 Email : Sanjeev.Chauhan@micro-precision.co.in
99	145-23000-A	ANUBAR (DELTA TUBE)	SWITZER PROCESS INSTRUMENTS PVT. LTD.	Mr. V S Jayaprakash, 128, SIDCO North Phase, Ambattur Estates CHENNAI Phone- 044-26252017/2018 Pincode : 600050 Email : sales@switzerprocess.co.in	Works-1->C S Shankar 127, Sidco North Phase, Ambattur Estates, -CHENNAI-TAMIL NADU INDIA Phone- 8754491904 FAX : 044-26248849 Pincode : 600050 Email : cservice@switzerinstrument.com
100	145-23000-A	ANUBAR (DELTA TUBE)	MINCO (INDIA) PRIVATE LIMITED	Mr. Rajeev Vasudeva, D/35, TIVIM INDUSTRIAL ESTATE, KARASWADA, MAPUSA, Goa, Phone- 9313637073 Pincode : 403526, Email : gicdelhi@general-gauges.com	Works-1-> D/35,TIVIM INDUSTRIAL ESTATE, KARASWADA,MAPUSA, -Goa-Goa India Phone- 9320197825, FAX : 0832-2257262, Pincode : 403526, Email : santoshkumar@general-gauges.com
101	145-25000-A	JUNCTION BOX	K.S.INSTRUMENTS PVT.LTD.	S Raghavan No. 72, 3rd Main, 1st Stage Industrial Suburb, Yeshwanthpur Bangalore Phone- 9880385770 Pincode : 560022 Email : sales1@ksinstruments.net	
102	145-25000-A	JUNCTION BOX	SUCHITRA INDUSTRIES	NO-2,OPP-27 AECS LAYOUT 2ND STG REJAMAHALVILAS EXTN 2ND STG BANGALORE Phone- Pincode : Email : suchitra.industriesblr@gmail.com	Works-1->B. Srinivas Suchitra Industries, Opp No 53, Muneshwara Black Devinagar, Lottagal hal -BANGALORE-KARNATAKA INDIA Phone- 080-23511247 FAX : Pincode : 560094 Email : suchitra_industries@yahoo.com

PACKAGE WISE REGISTERED SUPPLIER LIST (PERMANENT CATEGORY) AS ON 12/20/2018 12:46:42 PM

Sl No	Package Code	Package Name	Supplier Name	Supplier Communication Address	Supplier Works Address
103	145-25000-A	JUNCTION BOX	Shrenik & Company,	Mr. Mitesh Shah/Mr. Pulin Shah 39 A/3 ,Panchratna Industrial Estate, Sarkhej-Bavla Road Ahmedabad Phone- 9825024921 Pincode : 382213 Email : sales@pustron.com, pulin@sumip.com	Works-1->Mr.Pulin Shah/ Mr. Kaloesh Parmar 39 A/3 ,Panchratna Industrial Est,Sarkhej-Bavla Road, Changodhar - Ahmedabad-GUJARAT INDIA Phone- 98250 80339 1 FAX : 079-26932424 Pincode : 382213 Email : sales@sumip.com
104	145-25000-A	JUNCTION BOX	FLEXPRO ELECTRICALS PVT. LTD.	Mr. Dineshbhai Zaveri C-1/ 27&37, GIDC, Kabilpore, Navsari Phone- 02637-265140,265003 Pincode : 396424 Email : flexpro@flexproltd.com	Works-1->Mr. Dineshbhai Zaveri CEO C-1/ 27&37, GIDC, Kabilpore, -Navsari-GUJARAT INDIA Phone- 02637-265140,265003 FAX : 02637-265308 Pincode : 396424 Email : flexpro@flexproltd.com
105	145-25000-A	JUNCTION BOX	AJMERA INDUSTRIAL & ENGINEERING WORKS	JIGNESH MAHENDRA AJMERA DENA BANK BLDG.,SHREE NAGESH INDL. ESTATE,STATION ROAD, MUMBAI Phone- 022 67973578 Pincode : 400 088 Email : ajmera@ajmera.net, jmajmera@yahoo.com	Works-1->JIGNESH MAHENDRA AJMERA DENA BANK BLDG., SHREE NAGESHINDL. ESTATE,STATION ROAD, -MUMBAI-MAHARASHTRA INDIA Phone- 022 67973578 FAX : Pincode : 400 088 Email : ajmera@ajmera.net
106	145-31000-A	Cold Junction Compensation Box (CJCB)	CREATIVE INSTRUMENTS & CONTROLS	NO-17/1 , 1ST FLOOR , 11TH CROSS 1ST K BLOCK , RAJAJINAGAR, BANGALORE-560010 Phone- Pincode : Email : crinstruments@gmail.com	
107	145-32000-A	INSTRUMENTS TUBE FITTINGS	VIKAS INDUSTRIAL PRODUCTS	S.R.SINGH/NAVEEN SINGH B - 2, SECTOR - 6, NOIDA Phone- +91-9810122070 Pincode : 201301 Email : naveensingh@vsnl.com	Works-1->S.R.SINGH/ NAVEEN SINGH B - 2, SECTOR - 6, -NOIDA-UTTAR PRADESH INDIA Phone- 0120-4352940 FAX : 0120-4352940 Pincode : 201301 Email : naveensingh@vsnl.com
108	145-32000-A	INSTRUMENTS TUBE FITTINGS	Fluid Controls Pvt. Ltd.	Sophie Y. Moochhala/Mayur Rajput J.V.PATEL, I.T.I CMPD, B.MADHUKAR MARG, ELPHINSTONE ROADSTN.(WR), MUMBAI Phone- (022) 43338000 Pincode : 400013 Email : sales@fluidcontrols.com	Works-1->Mr. Tansen Choudhari/Mr. Mahesh Darekar Shed No.8, Lonavla Indl.Co-op.Estate Ltd,Nagargaon, -Lonavla-MAHARASHTRA INDIA Phone- 9823951347 FAX : (02114) 271132 Pincode : 410 401 Email : factory@hyd-air.com
109	145-32000-A	INSTRUMENTS TUBE FITTINGS	PRECISION ENGINEERING INDUSTRIES	K. SITARAM/ K. SRINIVAS 7,SIDHAPURA INDUSTRIAL ESTATE S.V. ROAD,GOREGAON(W) MUMBAI Phone- 022 42631700 Pincode : 400 062 Email : peiks@vsnl.com	Works-1->ALEX BAPTIST/ K. SRINIVAS 7. SIDHAPURA INDUSTRIAL ESTATE,SV ROAD, GOREGAON(WEST) -MUMBAI-MAHARASHTRA INDIA Phone- 022-42631700 FAX : 022-40035259 Pincode : 400 062 Email : srinivas@precision-engg.com
110	145-32000-A	INSTRUMENTS TUBE FITTINGS	AURA INCORPORATED	NIRAJ SHARAN/SUJIT KUMAR W-167A, GREATER KAILASH-II NEW DELHI Phone- 9810182430 Pincode : 110048 Email : niraj@aurainc.com	
111	145-33000-A	VENTURI METER	MICRO PRECISION PRODUCTS PVT. LTD.	Mr. SANJEEV CHAUHAN H.B. No.-40, Revenue Estate, Village-Dudhola,Tehsil & Distt. Palwal FARIDABAD Phone- 9871620282 Pincode : 121002 Email : Sanjeev.Chauhan@micro-precision.co.in	
112	145-33000-A	VENTURI METER	TM TECNOMATIC SPA	MR. ANTONIO NOVIELLO/Mrs. Enrica Bazzocc VIA DELLE INDUSTRIE, 36 CREMONA Phone- 39037221574 Pincode : 26100 Email : info@tmtecnomatic.com	Works-1->Mrs. Enrica Bazzocchi VIA DELLE INDUSTRIE, 36, -CREMONA- Italy Phone- 39037221574 FAX : 39037228318 Pincode : 26100 Email : sales@tmtecnomatic.com

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Sl No	Package Code	Package Name	Supplier Name	Supplier Communication Address	Supplier Works Address
113	145-33000-A	VENTURI METER	STAR-MECH CONTROLS (I) PVT.LTD.	SUSHILLOTAM, SUSHILLOTAM, 29/3A/3, SASANE NAGAR, HADAPSAR, PUNE Phone- 02026970450 Pincode : 411028 Email : marketing@starmech.net	Works-1->VIVEK GOTE/ MAHúNDRA BANSODE Sr no.54, Plot No.ll0,Swami ViVekanand Industrial Est.HADAPS -PUNE-MAHARASHTRA INDIA Phone- 02026970450 FAX : 02026970470 Pincode : 411028 Email : marketing@starmech.net
114	145-34000-A	ROTAMETER	INSTRUMENTATION ENGINEERS PVT LTD	SH.N.V.RAM GOPAL/MS. N.NIHARIKA PLOTS 1,2,3, PHASE-III, IDA, JEEDIMETLA HYDERABAD Phone- 9848407365 Pincode : 500055 Email : iedelhi@ieflowmeters.com	Works-1->MR. A.V.MURTHY/MR. K.T. RAVISANKER PLOTS 1,2,3, PHASE-III,IDA, JEEDIMETLA -HYDERABAD-TELANGANA INDIA Phone- 9885107312 FAX : 040-23096401 Pincode : 500055 Email : sales@ieflowmeters.com
115	145-34000-A	ROTAMETER	Flow Star Engineering Pvt. Ltd.,	MR. KHALID AKHTAR/MR. TAPAN KUMAR JANA Plot No-7 F/2, Northern India Industrial 20/3, Mathura Road FARIDABAD Phone- 9818176380 Pincode : 121005 Email : khalid@flowstar.co.in	Works-1->MR. KHALID AKHTAR/MR. TAPAN KUMAR JANA Plot No-7 F/2, Northern India Complex,20/3, Mathura Road -FARIDABAD-HARYANA INDIA Phone- 0129-4069661, FAX : 0129-4069663 Pincode : 121005 Email : tkjana@flowstar.co.in
116	145-34000-A	ROTAMETER	TANSA EQUIPMENTS PVT. LTD.	Mr. Vardhan Tamhankar, Unit No35/36/41,Om Anand Industrial Est. Mohanjee Sundarjee Road,Raghunath Nagar, Thane Phone- 022-25832323 Pincode : 400604 Email : tansaindia@gmail.com	Works-1-> Others Mohanjee Sundarjee Road, Raghunath Nagar, Thane -Mumbai-MAHARASHTRA INDIA Phone- FAX : Pincode : 400604 Email :
117	145-34000-A	ROTAMETER	EUREKA INDUSTRIAL EQUIPMENTS PVT.LTD.	Mr V. K. Pandit/Mr Ashish Shaha 17-20, Royal chambers, Paud Road Pune Phone- 9370469466 Pincode : 411038 Email : sales@eurekaflow.com	Works-1->Mr S. M. Alawani/Mr V. V. Deshpande J-501, M.I.D.C. Pimpri, -PUNE-MAHARASHTRA INDIA Phone- 9325751732 FAX : 020-30681731 Pincode : 411018 Email : works@eurekaflow.com
118	145-34000-A	ROTAMETER	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	Office no. 53, Shree Manoshi Complex, Plot No. 5 & 6, Sec-3, Ghansoli (East), Navi Mumbai, Phone- 9892230623, Pincode : 400 701, Email : sdbpl@vsnl.com	Works-1->Scientific Centre, S.No. 65, Hissa No. 7,By-Pass Juction, Kausa, -Mumbai-MAHARASHTRA INDIA Phone- 9892230623, FAX : 022-25491408/9 Pincode : 400 612, Email : sales@scientificdevices.com
119	145-35000-A	LEVEL SWITCH-CAPACITANCE TYPE	SIGMA INSTRUMENTS CO.	Gopal Kannan/R Gopinath 201, ANANDRAJ INDUSTRIAL ESTATE, OFF.LBS MARG, SONAPUR LANE, BHANDUP (W) MUMBAI Phone- +919821038162 Pincode : 400078 Email : sales@sigmainstruments.co.in	Works-1->R Gopinath 27 Nahur Udyog Industrial Premises,M.M.Malviya Road, Mulund(-MUMBAI-MAHARASHTRA INDIA Phone- +912225918567 FAX : +912225918566 Pincode : 400080 Email : sales@sigmainstruments.co.in
120	145-35000-A	LEVEL SWITCH-CAPACITANCE TYPE	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	Office no. 53, Shree Manoshi Complex, Plot No. 5 & 6, Sec-3, Ghansoli (East), Navi Mumbai, Phone- 9892230623, Pincode : 400 701, Email : sdbpl@vsnl.com	Works-1->Scientific Center, Others By-Pass Junction,Near Kalsekar College kausa, mumbra,Thane -Mumbai-MAHARASHTRA INDIA Phone- 022-25491409,9892230623 FAX : Pincode : 400612 Email : sdbpl@vsnl.com
121	145-35000-A	LEVEL SWITCH-CAPACITANCE TYPE	V. AUTOMAT & INTRUMENTS (P) LTD.	Mr. R. K. BASSI/Mr. PRAVEEN KUMAR F-61, OKHLA INDL.AREA, PH-1 NEW DELHI Phone- 9810005826 Pincode : 110 020 Email : sales@vautomat.com	Works-1->Mr. BHAGWAN SINGH/ Mr. NANDAN SINGH F-61, OKHLA INDL.AREA,PHASE-I -NEW DELHI-DELHI INDIA Phone- 011-47627200 Extn. 3 FAX : 011- 26819440 Pincode : 110 020 Email : production@vautomat.com

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Sl No	Package Code	Package Name	Supplier Name	Supplier Communication Address	Supplier Works Address
122	145-35000-A	LEVEL SWITCH-CAPACITANCE TYPE	LEVCON INSTRUMENTS PVT. LTD.	Mr Shayak Gupta/Badal Jana Rajkamal', 7th floor, 13, Camac Street KOLKATA Phone- 0 33 2283 2766 Pincode : 700017 Email : b_jana@levcongroup.com	
123	145-35000-A	LEVEL SWITCH-CAPACITANCE TYPE	Flow Star Engineering Pvt. Ltd.,	MR. KHALID AKHTAR/MR. TAPAN KUMAR JANA Plot No-7 F/2, Northern India Industrial 20/3, Mathura Road FARIDABAD Phone- 9818176380 Pincode : 121005 Email : khalid@flowstar.co.in	Works-1->MR. KHALID AKHTAR/MR. TAPAN KUMAR JANA Plot No-7 F/2, Northern India Complex,20/3, Mathura Road -FARIDABAD-HARYANA INDIA Phone- 0129-4069661, FAX : 0129-4069663 Pincode : 121005 Email : tkjana@flowstar.co.in
124	145-35000-A	LEVEL SWITCH-CAPACITANCE TYPE	Pune Techtrol Pvt. Ltd.	N.P.Khatan/Sudhakar Badiger S-18, MIDC Bhosari, Pune Phone- 9850560042 Pincode : 411 026 Email : ho@punetechtrol.com	
125	145-35000-A	LEVEL SWITCH-CAPACITANCE TYPE	Baumer Technologies India Pvt. Ltd.	Mr. Shyam Warilani/Mr. V Suresh Babu 36, DAMJI SHAMJI INDUSTRIAL COMPLEX, OFF.-MAHAKALI CAVES ROAD, ANDHERI(E) MUMBAI Phone- +91 99589 25151 Pincode : 400093 Email : sales.in@baumer.com	Works-1->Mr. Shyam Warilani/Mr. V Suresh Babu Plot No 34 À GIDC À Phase 1, -VAPI-GUJARAT INDIA Phone- +91 11 4161 7111 FAX : 022 2687 3613 Pincode : 396 195 Email : pbajaj@baumer.com
126	145-36000-A	LEVEL SWITCH-CONDUTIVITY TYPE	Sapcon Instrument Pvt Ltd.	131, PALSHIKAR COLONY Contact Person- Mr. Ashwin (9826080207) INDORE Phone- +91-731-4085751, Pincode : 452004 Email : sales@sapconinstruments.com	Works-1->Mr. Ashwin R Palshikar/Mr. Navin Bodse 131 PALSHIKAR COLONY, -INDORE-MADHYA PRADESH INDIA Phone- 9754261005 FAX : 0731-2475475 Pincode : 452004 Email : sales@sapcon.in
127	145-36000-A	LEVEL SWITCH-CONDUTIVITY TYPE	LEVCON INSTRUMENTS PVT. LTD.	Mr Shayak Gupta/Badal Jana Rajkamal', 7th floor, 13, Camac Street KOLKATA Phone- 0 33 2283 2766 Pincode : 700017 Email : b_jana@levcongroup.com	Works-1-> 38G, PICNIC GARDEN ROAD, -KOLKATA-WEST BENGAL INDIA Phone- FAX : Pincode : Email :
128	145-36000-A	LEVEL SWITCH-CONDUTIVITY TYPE	BLISS ANAND PVT. LTD.	Mr. Vikas Anand/ Mr.RGRajan 92B & 93 B , IMT MANESAR Gurgaon Phone- 0124-4366000 TO 9 Pincode : 122001 Email : sales@blissanand.com	Works-1->Mr. Bharat Kumar/ Mr. Sasi Kumar Plot No. 92B & 93B,Sec-V, IMTManesar -GURGAON-HARYANA INDIA Phone- 0124-4366000 TO 9 FAX : 0124-2290884 Pincode : 122002 Email : bharat@blissanand .com
129	145-36000-A	LEVEL SWITCH-CONDUTIVITY TYPE	V. AUTOMAT & INTRUMENTS (P) LTD.	Mr. R. K. BASSI/Mr. PRAVEEN KUMAR F-61, OKHLA INDL.AREA, PH-1 NEW DELHI Phone- 9810005826 Pincode : 110 020 Email : sales@vautomat.com	Works-1->Mr. BHAGWAN SINGH/ Mr. NANDAN SINGH F-61, OKHLA INDL.AREA,PHASE-I -NEW DELHI-DELHI INDIA Phone- 011-47627200 Extn. 3 FAX : 011- 26819440 Pincode : 110 020 Email : production@vautomat.com
130	145-36000-A	LEVEL SWITCH-CONDUTIVITY TYPE	HI-TECH SYSTEMS & SERVICES LTD.	Mr. Vikash Agrawal/Mr. Tarun Debnath 119, PARK STREET , KOLKATA Phone- 033-22290045 Pincode : 700016 Email : sandeep@hitech.in	Works-1->Mr. Jitendra Kumar/Mr. Debasis Dey 82/1, Sarsuna Main Road, -KOLKATA-WEST BENGAL INDIA Phone- 9883994030 FAX : Pincode : 700061 Email : jitendra@hitech.in
131	145-36000-A	LEVEL SWITCH-CONDUTIVITY TYPE	RAMAN INSTRUMENTS PVT.LTD.	Mr. N R Shenoy/Mr G B Vijh 8, First Floor.Plot : 160A Bait-Ush-Sharaf, 29th Road,Bandra(W) MUMBAI Phone- 09892331381 Pincode : 400050 Email : ramanbpl@vsnl.com	Works-1->NA -- Phone- FAX : Pincode : Email :

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Sl No	Package Code	Package Name	Supplier Name	Supplier Communication Address	Supplier Works Address
132	145-36000-A	LEVEL SWITCH-CONDUTIVITY TYPE	SIGMA INSTRUMENTS CO.	Gopal Kannan/R Gopinath 201, ANANDRAJ INDUSTRIAL ESTATE, OFF.LBS MARG, SONAPUR LANE, BHANDUP (W) MUMBAI Phone- +919821038162 Pincode : 400078 Email : sales@sigmainstruments.co.in	Works-1->R Gopinath 27 Nahur Udyog Industrial Premises,M.M.Malviya Road, Mulund(-MUMBAI-MAHARASHTRA INDIA Phone- +912225918567 FAX : +912225918566 Pincode : 400080 Email : sales@sigmainstruments.co.in
133	145-36000-A	LEVEL SWITCH-CONDUTIVITY TYPE	SOR INC.	LARRY DEGARMO/Avdhesh Chandra, 14685 W. 105TH STREET LENEXA Phone- 09810905139, Pincode : 66215 Email : Ldegarmo@sorinc.com, avdhesh@sherman-india.com,	Works-1->LARRY DEGARMO/ ROY STUMBOUGH 14685 W. 105TH STREET, LENEXA -KANSAS- USA Phone- 913-888-0767 FAX : 913-888-0767 Pincode : 66215 Email : rstumbough@sorinc.com
134	145-37000-A	LEVEL SWITCH-FLOAT TYPE	Pune Techtrol Pvt. Ltd.	N.P.Khatan/Sudhakar Badiger S-18, MIDC Bhosari, Pune Phone- 9850560042 Pincode : 411 026 Email : ho@punetechtrol.com	
135	145-37000-A	LEVEL SWITCH-FLOAT TYPE	D.K. INSTRUMENTS PVT.LTD.	N.SIKDAR/ SUMIT SIKDAR 76/2,SELIMPUR RD DHAKURIA Kolkata Phone- 033-2415-1310. Pincode : 700031 Email : dkinst@vsnl.net	
136	145-37000-A	LEVEL SWITCH-FLOAT TYPE	V. AUTOMAT & INTRUMENTS (P) LTD.	Mr. R. K. BASSI/Mr. PRAVEEN KUMAR F-61, OKHLA INDL.AREA, PH-1 NEW DELHI Phone- 9810005826 Pincode : 110 020 Email : sales@vautomat.com	Works-1->Mr. BHAGWAN SINGH/ Mr. NANDAN SINGH F-61, OKHLA INDL.AREA,PHASE-I -NEW DELHI-DELHI INDIA Phone- 011-47627200 Extn. 3 FAX : 011- 26819440 Pincode : 110 020 Email : production@vautomat.com
137	145-37000-A	LEVEL SWITCH-FLOAT TYPE	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	Office no. 53, Shree Manoshi Complex, Plot No. 5 & 6, Sec-3, Ghansoli (East), Navi Mumbai, Phone- 9892230623, Pincode : 400 701, Email : sdbpl@vsnl.com	Works-1->Scientific Center, Others By-Pass Junction,Near Kalsekar College kausa, mumbra,Thane -Mumbai-MAHARASHTRA INDIA Phone- 022-25491409,9892230623 FAX : Pincode : 400612 Email : sdbpl@vsnl.com
138	145-37000-A	LEVEL SWITCH-FLOAT TYPE	LEVCON INSTRUMENTS PVT. LTD.	Mr Shayak Gupta/Badal Jana Rajkamal', 7th floor, 13, Camac Street KOLKATA Phone- 0 33 2283 2766 Pincode : 700017 Email : b_jana@levcongroup.com	
139	145-37000-A	LEVEL SWITCH-FLOAT TYPE	GENERAL INSTRUMENTS CONSORTIUM	Mr. Amarendra Kulkarni 194/195, Gopi Tank Road, Off. Pandurang Naik Marg, Mahim Mumbai Phone- 9323195251 Pincode : 400016 Email : amarendra@general-gauges.com	
140	145-37000-A	LEVEL SWITCH-FLOAT TYPE	SBEM PVT. LTD.	MR.N.K. BEDARKAR/MR. VISHWANATH KARANDIK 39, ELECTRONIC CO.OP. ESTATE, PUNE SATARA ROAD PUNE, Phone- 912041030100 Pincode : 411009 Email : newdelhi@sbem.co.in	Works-1->MR. MOHAN PADWAL 691/A/2,BIBWEWADI INDL ESTATE -PUNE-MAHARASHTRA INDIA Phone- 918600042374 FAX : 912024215670 Pincode : 411037 Email : wm@sbem.co.in
141	145-37000-A	LEVEL SWITCH-FLOAT TYPE	Baumer Technologies India Pvt. Ltd.	Mr. Shyam Warilani/Mr. V Suresh Babu 36, DAMJI SHAMJI INDUSTRIAL COMPLEX, OFF.-MAHAKALI CAVES ROAD, ANDHERI(E) MUMBAI Phone- +91 99589 25151 Pincode : 400093 Email : sales.in@baumer.com	Works-1->Mr. Shyam Warilani/Mr. V Suresh Babu Plot No 34 À GIDC À Phase 1, -VAPI-GUJARAT INDIA Phone- +91 11 4161 7111 FAX : 022 2687 3613 Pincode : 396 195 Email : pbajaj@baumer.com

PACKAGE WISE REGISTERED SUPPLIER LIST (PERMANENT CATEGORY) AS ON 12/20/2018 12:46:42 PM

Sl No	Package Code	Package Name	Supplier Name	Supplier Communication Address	Supplier Works Address
142	145-37000-A	LEVEL SWITCH-FLOAT TYPE	SIGMA INSTRUMENTS CO.	Gopal Kannan/R Gopinath 201, ANANDRAJ INDUSTRIAL ESTATE, OFF.LBS MARG, SONAPUR LANE, BHANDUP (W) MUMBAI Phone- +919821038162 Pincode : 400078 Email : sales@sigmainstruments.co.in	Works-1->R Gopinath 27 Nahur Udyog Industrial Premises,M.M.Malviya Road, Mulund(-MUMBAI-MAHARASHTRA INDIA Phone- +912225918567 FAX : +912225918566 Pincode : 400080 Email : sales@sigmainstruments.co.in
143	145-37000-A	LEVEL SWITCH-FLOAT TYPE	SOR INC.	LARRY DEGARMO/Avdhesh Chandra, 14685 W. 105TH STREET LENEXA Phone- 09810905139, Pincode : 66215 Email : Ldegarmo@sorinc.com, avdhesh@sherman-india.com,	Works-1->LARRY DEGARMO/ ROY STUMBOUGH 14685 W. 105TH STREET, LENEXA -KANSAS- USA Phone- 913-888-0767 FAX : 913-888-0767 Pincode : 66215 Email : rstumbough@sorinc.com
144	145-38000-A	INSTRUMENTS PIPE FITTINGS	VIKAS INDUSTRIAL PRODUCTS	S.R.SINGH/NAVEEN SINGH B - 2, SECTOR - 6, NOIDA Phone- +91-9810122070 Pincode : 201301 Email : naveensingh@vsnl.com	Works-1->S.R.SINGH/ NAVEEN SINGH B - 2, SECTOR - 6, -NOIDA-UTTAR PRADESH INDIA Phone- 0120-4352940 FAX : 0120-4352940 Pincode : 201301 Email : naveensingh@vsnl.com
145	145-38000-A	INSTRUMENTS PIPE FITTINGS	Fluid Controls Pvt. Ltd.	Sophie Y. Moochhala/Mayur Rajput J.V.PATEL, I.T.I CMPD, B.MADHUKAR MARG, ELPHINSTONE ROADSTN.(WR), MUMBAI Phone- (022) 43338000 Pincode : 400013 Email : sales@fluidcontrols.com	Works-1->Mr. Tansen Choudhari/Mr. Mahesh Darekar Shed No.8, Lonavla Indl.Co-op.Estate Ltd,Nagargaon, -Lonavla-MAHARASHTRA INDIA Phone- 9823951347 FAX : (02114) 271132 Pincode : 410 401 Email : factory@hyd-air.com
146	145-38000-A	INSTRUMENTS PIPE FITTINGS	AURA INCORPORATED	NIRAJ SHARAN/SUJIT KUMAR W-167A, GREATER KAILASH-II NEW DELHI Phone- 9810182430 Pincode : 110048 Email : niraj@aurainc.com	
147	145-38000-A	INSTRUMENTS PIPE FITTINGS	PRECISION ENGINEERING INDUSTRIES	K. SITARAM/ K. SRINIVAS 7,SIDHAPURA INDUSTRIAL ESTATE S.V. ROAD,GOREGAON(W) MUMBAI Phone- 022 42631700 Pincode : 400 062 Email : peiks@vsnl.com	Works-1->ALEX BAPTIST/ K. SRINIVAS 7. SIDHAPURA INDUSTRIAL ESTATE,SV ROAD, GOREGAON(WEST) -MUMBAI-MAHARASHTRA INDIA Phone- 022-42631700 FAX : 022-40035259 Pincode : 400 062 Email : srinivas@precision-engg.com
148	145-42000-A	ULTRASONIC FLOW METERS	Adept Fluidyne Pvt. Ltd.	Vinayak Gadre Plot No 4,S.No.17/1-B Kothrud Industrial Estate Pune Phone- 020 25464551 Pincode : 411038 Email : info@adeptfluidyne.com	Works-1-> Plot No 4,S.No.17/1-B Kothrud Industrial Estate -Pune-MAHARASHTRA india Phone- 020 25464551 FAX : Pincode : 411038 Email : info@adeptfluidyne.com
149	145-42000-A	ULTRASONIC FLOW METERS	FLEXIM Flexible Industriemesstechnik GmbH	Boxberger Str., 4, Berlin Berlin Phone- 0049 30 93 66 76 60 Pincode : 12681 Email : info@flexim.de	Works-1-> Others Boxberger Str. 4, -Berlin-GERMANY Phone- 0049 30 93 66 76 60 FAX : Pincode : 12681 Email : info@flexim.de
150	145-42000-A	ULTRASONIC FLOW METERS	Rockwin Flowmeter India Pvt. Ltd.	B-24, Site-IV, Sahibabad Industrial Area Ghaziabad, Phone- 9810129687 Pincode : 201010, Email : amiya@rockwin.com	Works-1->MR Rajiv PRAKASH B-24, Site-IV, Sahibabad Industrial Area, -Ghaziabad-UTTAR PRADESH India Phone- 9810129687 FAX : 01202895450 Pincode : 201010, Email : rajiv@rockwin.com
151	145-42000-A	ULTRASONIC FLOW METERS	FLASH FORGE PVT LTD	Mr. Gautam Makker, 503, 'A'-wing, Delphi, Orchard Avenue Road, Powai Mumbai Phone- 022-42784300 Pincode : 400076 Email : hemendrapatil@f-f.co.in	Works-1-> Others M/s Endress & Hauser, Aurangabad, Maharastra -Aurangabad-MAHARASHTRA INDIA Phone- FAX : Pincode : Email : Works-2->+ Others M/s Endress & Hauser, Bhiwandi,Thane -Thane-MAHARASHTRA INDIA Phone- FAX : Pincode : Email :

PACKAGE WISE REGISTERED SUPPLIER LIST (PERMANENT CATEGORY) AS ON 12/20/2018 12:46:42 PM

Sl No	Package Code	Package Name	Supplier Name	Supplier Communication Address	Supplier Works Address
152	145-42000-A	ULTRASONIC FLOW METERS	Electronet Equipments Pvt Ltd.	Plot No. 84, 85 & 86, Tiny Industrial Estate Kondhwa Budruk, Pune Phone- 020-2026932039 Pincode : 411048 Email : ho@eeplindia.com	Works-1-> Others Plot No. 84, 85 & 86, Tiny Industrial Estate, Kondhwa Budruk - Pune-MAHARASHTRA INDIA Phone- 20-26932039 FAX : 20-26934122 Pincode : 411048 Email : ho@eeplindia.com
153	145-42000-A	ULTRASONIC FLOW METERS	NIVUS GMBH	Mr. Marcus Fischer Im Taele 2, D - 75031 Eppingen Phone- 00491712233770 Pincode : Email : carolin.schuster@nivus.com	Works-1->Mr. Marcus Fischer CEO Im Taele 2, Eppingen, -Baden Wuerttemberg,-Foreign Country GERMANY Phone- 0049-726291910 FAX : Pincode : 75031 Email : carolin.schuster@nivus.com
154	145-43000-A	FLOW ELEMENT - ORIFICE	TANSA EQUIPMENTS PVT. LTD.	Mr. Vardhan Tamhankar, Unit No35/36/41,Om Anand Industrial Est. Mohanjee Sundarjee Road,Raghunath Nagar, Thane Phone- 022-25832323 Pincode : 400604 Email : tansaindia@gmail.com	Works-1-> Others Mohanjee Sundarjee Road, Raghunath Nagar, Thane -Mumbai-MAHARASHTRA INDIA Phone- FAX : Pincode : 400604 Email :
155	145-43000-A	FLOW ELEMENT - ORIFICE	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	Office no. 53, Shree Manoshi Complex, Plot No. 5 & 6, Sec-3, Ghansoli (East), Navi Mumbai, Phone- 9892230623, Pincode : 400 701, Email : sdbpl@vsnl.com	Works-1->Scientific Center, Others By-Pass Junction,Near Kalsekar College kausa, mumbra,Thane -Mumbai-MAHARASHTRA INDIA Phone- 022-25491409,9892230623 FAX : Pincode : 400612 Email : sdbpl@vsnl.com
156	145-43000-A	FLOW ELEMENT - ORIFICE	MINCO (INDIA) PRIVATE LIMITED	Mr. Rajeev Vasudeva, D/35, TIVIM INDUSTRIAL ESTATE, KARASWADA, MAPUSA, Goa, Phone- 9313637073 Pincode : 403526, Email : gicdelhi@general-gauges.com	Works-1-> D/35,TIVIM INDUSTRIAL ESTATE, KARASWADA,MAPUSA, -Goa-Goa India Phone- 9320197825, FAX : 0832-2257262, Pincode : 403526, Email : santoshkumar@general-gauges.com
157	145-43000-A	FLOW ELEMENT - ORIFICE	CHEMTROLS INDUSTRIES PVT. LTD.	Mr. K. NANDAKUMAR AMAR HILL, SAKI VIHAR ROAD, POWAI, MUMBAI Phone- 022-67151261 Pincode : 400072 Email : manikandan@chemtrols.com	Works-2->+Works -II :M/s Chemtrols Samil (I) Pvt. Ltd.,Plot No.F-43,44 Others Additional Ambernath Industrial ,M.I.D.C., Ambernath - Thane-MAHARASHTRA INDIA Phone- 22-67151261,9821014902 FAX : 91-22-28571913 Pincode : 421503 Email : manikandan@chemtrols.com
158	145-43000-A	FLOW ELEMENT - ORIFICE	STAR-MECH CONTROLS (I) PVT.LTD.	SUSHILLOTAM, SUSHILLOTAM, 29/3A/3, SASANE NAGAR, HADAPSAR, PUNE Phone- 02026970450 Pincode : 411028 Email : marketing@starmech.net	Works-1->VlVEK GOTE/ MAHúNDRA BANSODE Sr no.54, Plot No.ll0,Swami ViVekanand Industrial Est.HADAPS -PUNE-MAHARASHTRA INDIA Phone- 02026970450 FAX : 02026970470 Pincode : 411028 Email : marketing@starmech.net
159	145-43000-A	FLOW ELEMENT - ORIFICE	INSTRUMENTATION LTD.	KANJIKODE WEST, PALALKKAD, PALAKKAD Phone- 2566127-130,2567128 Pincode : 678623 Email : icvldil@gmail.com;fa2@ilpgt.com	Works-1->D.SASIDHARAN, AGM(Works&PPC) KANJIKODE WEST, - PALAKKAD-KERALA INDIA Phone- 0491-2566536 FAX : 0491-2566135 Pincode : 678623 Email : sasidharan@ilpgt.com
160	145-43000-A	FLOW ELEMENT - ORIFICE	HYDROPNEUMATICS PVT. LTD.	Mr. DM Bichu G/B, Hill Crown Apts., College Road Mapusa Phone- 0832-2360364 Pincode : 403507 Email : ajayrc@hydropneumatics.co.in	Works-1->Mr. DM Bichu D2/6, Bicholim Industrial Estate, -Bicholim-Goa India Phone-0832-2360364 FAX : 0832-2360368 Pincode : 403529 Email : ajayrc@hydropneumatics.co.in
161	145-43000-A	FLOW ELEMENT - ORIFICE	Flow Star Engineering Pvt. Ltd.,	MR. KHALID AKHTAR/MR. TAPAN KUMAR JANA Plot No-7 F/2, Northern India Industrial 20/3, Mathura Road FARIDABAD Phone- 9818176380 Pincode : 121005 Email : khalid@flowstar.co.in	Works-1->MR. KHALID AKHTAR/MR. TAPAN KUMAR JANA Plot No-7 F/2, Northern India Complex,20/3, Mathura Road -FARIDABAD-HARYANA INDIA Phone- 0129-4069661, FAX : 0129-4069663 Pincode : 121005 Email : tkjana@flowstar.co.in

PACKAGE WISE REGISTERED SUPPLIER LIST (PERMANENT CATEGORY) AS ON 12/20/2018 12:46:42 PM

Sl No	Package Code	Package Name	Supplier Name	Supplier Communication Address	Supplier Works Address
162	145-43000-A	FLOW ELEMENT - ORIFICE	MICRO PRECISION PRODUCTS PVT. LTD.	Mr. SANJEEV CHAUHAN H.B. No.-40, Revenue Estate, Village-Dudhola,Tehsil & Distt. Palwal FARIDABAD Phone- 9871620282 Pincode : 121002 Email : Sanjeev.Chauhan@micro-precision.co.in	Works-1->Mr. SANJEEV CHAUHAN ,H.B. No.-40 Others Revenue Estate, Village-Dudhola, Tehsil & Distt.-Palwal -Faridabad-Haryana India Phone- 9871620282 FAX : Pincode : 121002 Email : Sanjeev.Chauhan@micro-precision.co.in
163	145-43000-A	FLOW ELEMENT - ORIFICE	INSTRUMENTATION ENGINEERS PVT LTD	SH.N.V.RAM GOPAL/MS. N.NIHARIKA PLOTS 1,2,3, PHASE-III, IDA, JEEDIMETLA HYDERABAD Phone- 9848407365 Pincode : 500055 Email : iedelhi@ieflowmeters.com	Works-1->MR. A.V.MURTHY/MR. K.T. RAVISANKER PLOTS 1,2,3, PHASE-III,IDA, JEEDIMETLA -HYDERABAD-TELANGANA INDIA Phone- 9885107312 FAX : 040-23096401 Pincode : 500055 Email : sales@ieflowmeters.com
164	145-43000-A	FLOW ELEMENT - ORIFICE	MINCO (INDIA) FLOW ELEMENTS PVT. LTD.	Mr. Raghavendra M. Kulkarni D2-49/50, Tivim Industrial Estate, Karaswada Mapusa Phone- 0832-2257059 Pincode : 403526 Email : gicflowelement@giconindia.com	Works-1->Mr. Raghavendra M. Kulkarni Dir D2-49/50, Tivim Industrial Estate,Karaswada -Mapusa-GOA INDIA Phone- 0832-2257059 FAX : 022-24455026 Pincode : 403526 Email : gicflowelement@giconindia.com
165	145-43000-A	FLOW ELEMENT - ORIFICE	DYNAFLUID VALVES AND FLOW CONTROLS (P) LTD.	Mr. Yogish M. Kulkarni Plot # 23, Udyambag, Belgaum Phone- 0831-4210386 Pincode : 590008 Email : yogish@dyna-fluid.com	Works-1->Mr. Yogish M. Kulkarni Dir Plot # 23, Udyambag, -Belgaum-KARNATAKA INDIA Phone- 0831-4210386 FAX : 0831-4210386 Pincode : 590008 Email : yogish@dyna-fluid.com
166	145-45000-A	INSTRUMENT FITTINGS	Arya Crafts & Engineering Pvt. Ltd.	Mr.Sanjay Brahman/Mr.Shyam Vazirani 102, Vora Industrial Estate No.4 Navghar, Vasai Road (E) Dist.Thane, Mumbai Phone- +91-250-2392246 Pincode : 401210 Email : arya@aryaengg.com	
167	145-45000-A	INSTRUMENT FITTINGS	Perfect Instrumentation Control (India) Pvt. Ltd.	MD Hussain Shaikh/Shahanawaz Khan Gala No. 168, Loheki Chwal,216/ 218, Maulana Azad Rd. Nagpada Junction Mumbai Phone- 91-9324383121 Pincode : 400008 Email : shahanawaz.khan@perfectinstrumentation.com	Works-1->Shahanawaz Khan Vishweshwar Ind. Premises Co-op Soc. Ltd,F-18/19, Pradhikaran,Bhosadi MIDC -PUNE-MAHARASHTRA INDIA Phone- 020-30694134 FAX : 022-23013010 Pincode : 411026 Email : shahanawaz.khan@perfectinstrumentation.com
168	145-45000-A	INSTRUMENT FITTINGS	HP VALVES & FITTINGS INDIA PVT. LTD.	S. Harichandran/P.S. Pandi B-11, Mugappair Industrial Estate, CHENNAI Phone- 044 26252537 Pincode : 600037 Email : sales@hpvalvesindia.com	Works-1->S. Harichandran/ P.S. Pandi B-11, Mugappair Industrial Estate, -CHENNAI-TAMIL NADU INDIA Phone- 044-25252537 FAX : 044-26252538 Pincode : 600037 Email : sales@hpvalvesindia.com
169	145-45000-A	INSTRUMENT FITTINGS	Comfit & Valve Pvt. Ltd.	Mr. Jeetu Jain/Mr. Vinay Sosa Survey No. 23/1, Part 2, Ahmedabad-Mehsana Highway Laxmipura, Nandasan Phone- 02764-267036/37 Pincode : 382705 Email : marketing@com-fit.com	Works-1->Miss Sonal Pithadia/Miss Pavan Chavda Survey No. 23/1, Part 2, Ahmedabad-Mehsana Highway, Laxmipura -Nandasan-GUJARAT INDIA Phone- 8460848087 FAX : 2764-267036/37 Pincode : 382705 Email : domestic@com-fit.com
170	145-45000-A	INSTRUMENT FITTINGS	PRECISION ENGINEERING INDUSTRIES	K. SITARAM/ K. SRINIVAS 7,SIDHAPURA INDUSTRIAL ESTATE S.V. ROAD,GOREGAON(W) MUMBAI Phone- 022 42631700 Pincode : 400 062 Email : peiks@vsnl.com	Works-1->ALEX BAPTIST/ K. SRINIVAS 7. SIDHAPURA INDUSTRIAL ESTATE,SV ROAD, GOREGAON(WEST) -MUMBAI-MAHARASHTRA INDIA Phone- 022-42631700 FAX : 022-40035259 Pincode : 400 062 Email : srinivas@precision-engg.com

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Sl No	Package Code	Package Name	Supplier Name	Supplier Communication Address	Supplier Works Address
171	145-45000-A	INSTRUMENT FITTINGS	AURA INCORPORATED	NIRAJ SHARAN/SUJIT KUMAR W-167A, GREATER KAILASH-II NEW DELHI Phone- 9810182430 Pincode : 110048 Email : niraj@aurainc.com	
172	145-45000-A	INSTRUMENT FITTINGS	FLUIDFIT ENGINEERS PVT. LTD.	Mr. Abbas Bhola Potia Building No. 2, Office No. 3,292, Bellasis Road,Mumbai Central (East) Mumbai Phone- 9920044113 Pincode : 400008 Email : ab@fluidfitengg.com	Works-1->Mr. Abbas Bhola Unit No. 16, Supreme Industrial Estate,Kaman Bhiwandi Road,Devdal, -Vasai East-MAHARASHTRA India Phone- 9920044113 FAX : 07303178243 Pincode : 401208 Email : ab@fluidfitengg.com
173	145-45000-A	INSTRUMENT FITTINGS	VIKAS INDUSTRIAL PRODUCTS	S.R.SINGH/NAVEEN SINGH B - 2, SECTOR - 6, NOIDA Phone- +91-9810122070 Pincode : 201301 Email : naveensingh@vsnl.com	Works-1->S.R.SINGH/ NAVEEN SINGH B - 2, SECTOR - 6, -NOIDA-UTTAR PRADESH INDIA Phone- 0120-4352940 FAX : 0120-4352940 Pincode : 201301 Email : naveensingh@vsnl.com
174	145-45000-A	INSTRUMENT FITTINGS	Fluid Controls Pvt. Ltd.	Sophie Y. Moochhala/Mayur Rajput J.V.PATEL, I.T.I CMPD, B.MADHUKAR MARG, ELPHINSTONE ROADSTN.(WR), MUMBAI Phone-(022) 43338000 Pincode : 400013 Email : sales@fluidcontrols.com	Works-1->Mr. Tansen Choudhari/Mr. Mahesh Darekar Shed No.8, Lonavla Indl.Co-op.Estate Ltd,Nagargaon, -Lonavla-MAHARASHTRA INDIA Phone- 9823951347 FAX : (02114) 271132 Pincode : 410 401 Email : factory@hyd-air.com
175	145-45000-A	INSTRUMENT FITTINGS	PANAM ENGINEERS	Mr. Santosh Shukla 203, Jaisingh Business,Parsiwada, Sahar road,Andheri(East), Mumbai, Phone-9892179529, Pincode : 400099, Email : santosh@panamengineers.com.	Works-1->Mr. Santosh Shukla Others R-628,TTC Industrial Area, MIDC Rabale, -Navi Mumbai-MAHARASHTRA India Phone-9821350761, FAX : 022-27695559, Pincode : 400701, Email : sales@panamengineers.com
176	145-47000-A	ELECTROMAGNETIC FLOW METER	V.A Valves	Mr.Vishal Jain, Udyog Nagar, Gadaipur, Jalandhar Phone-9872626376 Pincode : 144004 Email : support@fedrelflowmeters.com	Works-1->Mr.Vishal Jain Dir Udyog Nagar, Gadaipur, -Jalandhar-PUNJAB INDIA Phone-01812601741,9872626376 FAX : Pincode : 144004 Email : support@fedrelflowmeters.com
177	145-47000-A	ELECTROMAGNETIC FLOW METER	Adept Fluidyne Pvt. Ltd.	Vinayak Gadre Plot No 4,S.No.17/1-B Kothrud Industrial Estate Pune Phone- 020 25464551 Pincode : 411038 Email : info@adeptfluidyne.com	Works-1-> Plot No 4,S.No.17/1-B Kothrud Industrial Estate -Pune-MAHARASHTRA india Phone- 020 25464551 FAX : Pincode : 411038 Email : info@adeptfluidyne.com
178	145-47000-A	ELECTROMAGNETIC FLOW METER	Electronet Equipments Pvt Ltd.	Plot No. 84, 85 & 86, Tiny Industrial Estate Kondhwa Budruk, Pune Phone- 020-2026932039 Pincode : 411048 Email : ho@eeplindia.com	Works-1-> Others Plot No. 84, 85 & 86, Tiny Industrial Estate, Kondhwa Budruk -Pune-MAHARASHTRA INDIA Phone- 20-26932039 FAX : 20-26934122 Pincode : 411048 Email : ho@eeplindia.com
179	145-47000-A	ELECTROMAGNETIC FLOW METER	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	Office no. 53, Shree Manoshi Complex, Plot No. 5 & 6, Sec-3, Ghansoli (East), Navi Mumbai, Phone- 9892230623, Pincode : 400 701, Email : sdbpl@vsnl.com	Works-1->Scientific Center, Others By-Pass Junction,Near Kalsekar College kausa, mumbra,Thane -Mumbai-MAHARASHTRA INDIA Phone- 022-25491409,9892230623 FAX : Pincode : 400612 Email : sdbpl@vsnl.com

INSTRUMENT INSTALLATION DRAWING

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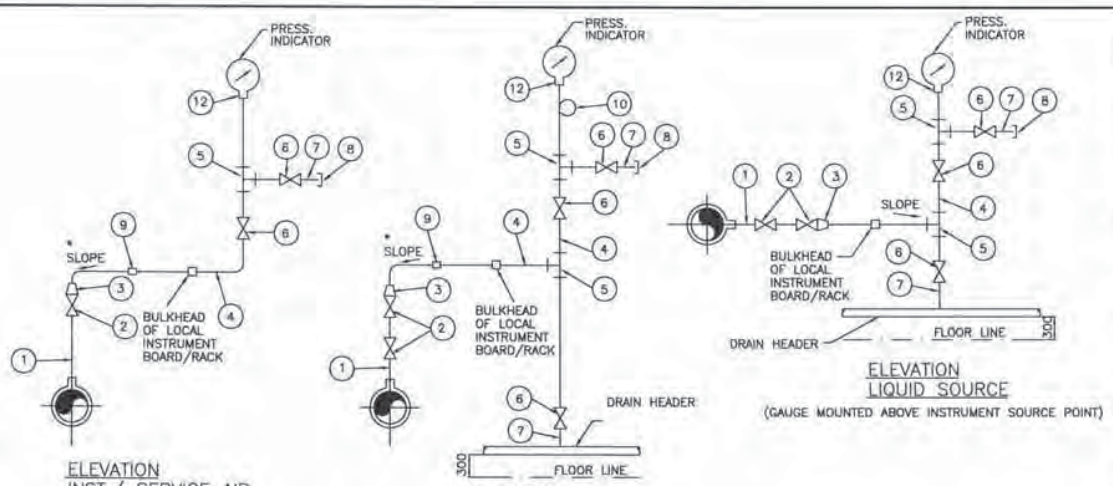


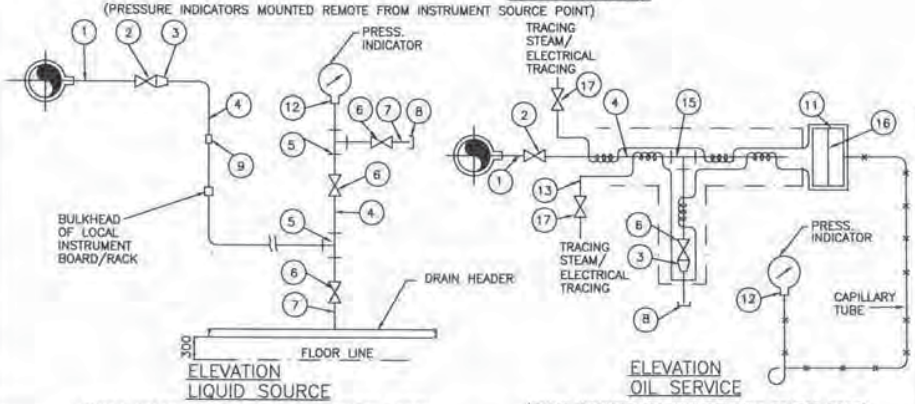
ELEVATION
INST./ SERVICE AIR

(PRESSURE INDICATORS MOUNTED REMOTE FROM INSTRUMENT SOURCE POINT)

ELEVATION
STEAM SERVICE

ELEVATION
LIQUID SOURCE

(GAUGE MOUNTED ABOVE INSTRUMENT SOURCE POINT)



ELEVATION
LIQUID SOURCE

(GAUGE MOUNTED BELOW INSTRUMENT SOURCE POINT)

ELEVATION
OIL SERVICE

(GAUGE MOUNTED BELOW INSTRUMENT SOURCE POINT)

LIST OF MATERIALS

ITEM NO.	DESCRIPTION
1.	1/2" , 3/4" , 1" NPS SCH 40/80/160/XXS/P91 (AS PER PROCESS REQUIREMENT) NIPPLE OF MATERIAL SAME AS THAT OF MAIN PIPE.
2.	1/2"/3/4"/1' SW GLOBE VALVE/GATE VALVE
3.	3/4" / 1" x 1/2" SW REDUCING INSERT
4.	1/2" / 3/4" PIPE
5.	1/2" / 3/4" SW EQUAL TEE
6.	1/2" / 3/4" SW GLOBE VALVE.
7.	1/2" / 3/4" NPS SW x 1/2" / 3/4" NPT(M) CARBON/ALLOY STEEL NIPPLE.
8.	1/2" / 3/4" NPT(F) CAP.
9.	1/2" / 3/4" PIPE UNION.
10.	6" SS SYPHON
11.	1/2" BLIND 300lbs RF ANSI FLANGE DRILLED AND TAPED FOR 1" NPT PIPE.
12.	SUITABLE ADAPTER.
13.	1/4" CHROME MOLY STEEL TUBE.
14.	
15.	1"/3/4" SW EQUAL TEE.
16.	DIAPHRAGM(WAFER ELEMENT)
17.	ISOLATION VALVE 316 SS,1/4"SW

NOTES:-

1. THE MATERIAL SPECIFICATION AND SCHEDULE NO. OF IMPULSE PIPE & NIPPLE AS LISTED HEREIN SHALL BE AS PER TECHNICAL SPECIFICATIONS.
2. THE MATERIAL SPECIFICATION AND RATING OF FITTINGS AS LISTED SHALL BE AS PER SPECIFICATIONS. WELDED/THREADED FITTINGS SHALL CONFIRM TO ANSI-B.16-11.
3. INSTRUMENTS VALVES BODY STEM MATERIAL AND PRESSURE CLASS SHALL BE AS PER TECHNICAL SPECIFICATIONS.
4. FOR BOILER AIR/FLUE GAS SERVICES SOURCE CONNECTIONS IMPULSE PIPING AND ALL FITTINGS SHALL BE OF 3/4" NB SIZE.
5. GAUGES SHALL NOT BE MOUNTED ON THE PIPE. IT WILL BE MOUNTED ON A CHANNEL OR FRAME OR A RACK.
6. * SLOPE APPROX. 50 MM / METRE.

FOR TENDER PURPOSE ONLY

REV.NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	E	C	C&I	ARCH.	APPD	DATE
A	FIRST ISSUE							T.G.			21.08.12

CLEARED BY

एन टी पी सी NTPC

N T P C LIMITED
(A GOVERNMENT OF INDIA ENTERPRISE)
ENGINEERING DIVISION

PROJECT: TYPICAL THERMAL POWER PROJECT

TITLE: INSTRUMENT INSTALLATION DIAGRAM (FOR PRESSURE GAUGE)

SIZE	SCALE	DRG. NO.	REV. NO.
A3	N.T.S.	0000-999-POI-A-022	A

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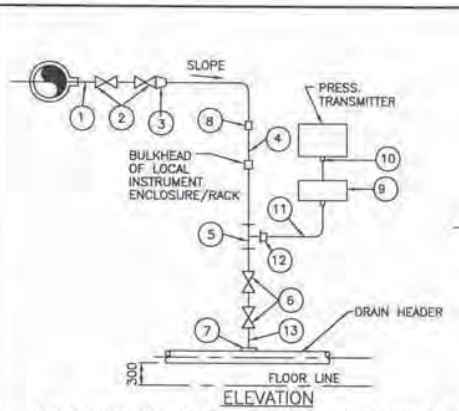
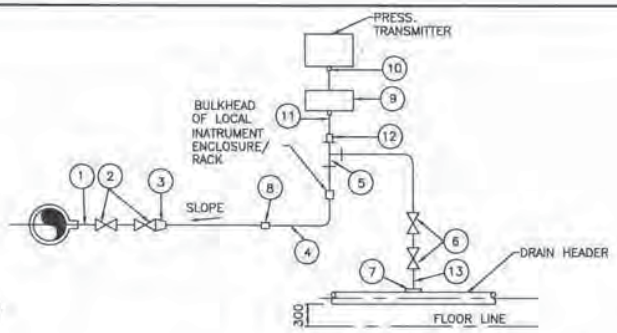


ELEVATION

TRANSMITTER MOUNTED BELOW INSTRUMENT SOURCE POINT



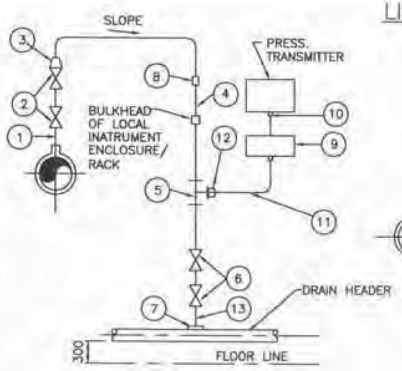
ELEVATION

TRANSMITTER MOUNTED ABOVE INSTRUMENT SOURCE POINT

LIQUID PRESSURE MEASUREMENT

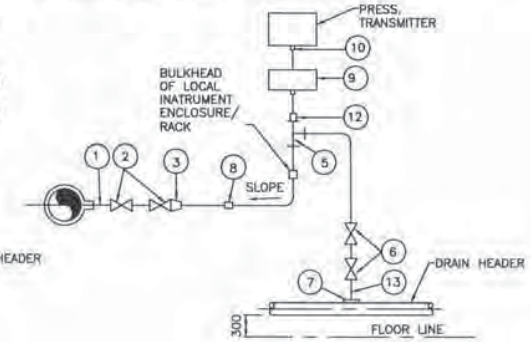
LIST OF MATERIALS

ITEM NO.	DESCRIPTION
1.	1/2"/ 3/4"/1"NPS SCH. 80/160/XXS/P91 NIPPLE OF MATERIAL SAME AS THAT OF MAIN PIPE.
2.	3/4"/1" SW GLOBE VALVE.
3.	3/4"/1" TO 1/2" REDUCING INSERT
4.	1/2" NPS PIPE
5.	1/2" SW EQUAL TEE
6.	1/2"SW GLOBE VALVE
7.	1/2"NPS SCH. 80/160 SWx1/2"CS/AS COUPLER
8.	1/2" PIPE UNION
9.	2/3 VALVE MANIFOLD (FOR DETAIL SEE DRAWING NO.0000-102-POI-A-023.
10.	SUITABLE ADAPTER
11.	SS TUBE
12.	1/2" PIPE x 1/2"TUBE UNION
13.	1/2"NPS SCH. 80/160 SWx1/2" NPT(M) CS/AS NIPPLE



ELEVATION

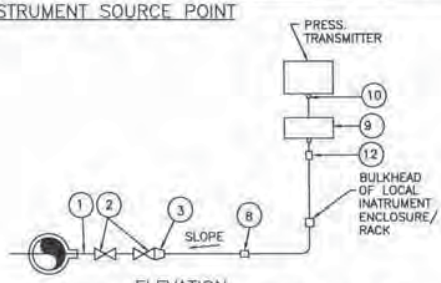
TRANSMITTER MOUNTED BELOW INSTRUMENT SOURCE POINT



ELEVATION

TRANSMITTER MOUNTED ABOVE INSTRUMENT SOURCE POINT

STEAM PRESSURE MEASUREMENT



ELEVATION

VACCUM PRESSURE MEASUREMENT

NOTES:-

1. SAME NOTES UNDER DRG. NO. 0000-999-POI-A-023.
2. FOR VACUUM APPLICATION OTHER PORT OF TRANSMITTER SHALL BE KEPT OPEN TO ATMOSPHERE.

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REV.NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	E	C	C&I	ARCH.	APPD	DATE
A	FIRST ISSUE							T.G.			21.08.12
					CLEARED BY						

PROJECT: TYPICAL THERMAL POWER PROJECT

TITLE: INSTRUMENT INSTALLATION DIAGRAM (PRESSURE MEASUREMENT USING PRESS /DP TRANSMITTERS STEAM/LIQUID VACUUM)

SIZE	SCALE	DRG. NO.	REV. NO.
A3	N.T.S.	0000-999-POI-A-025	A

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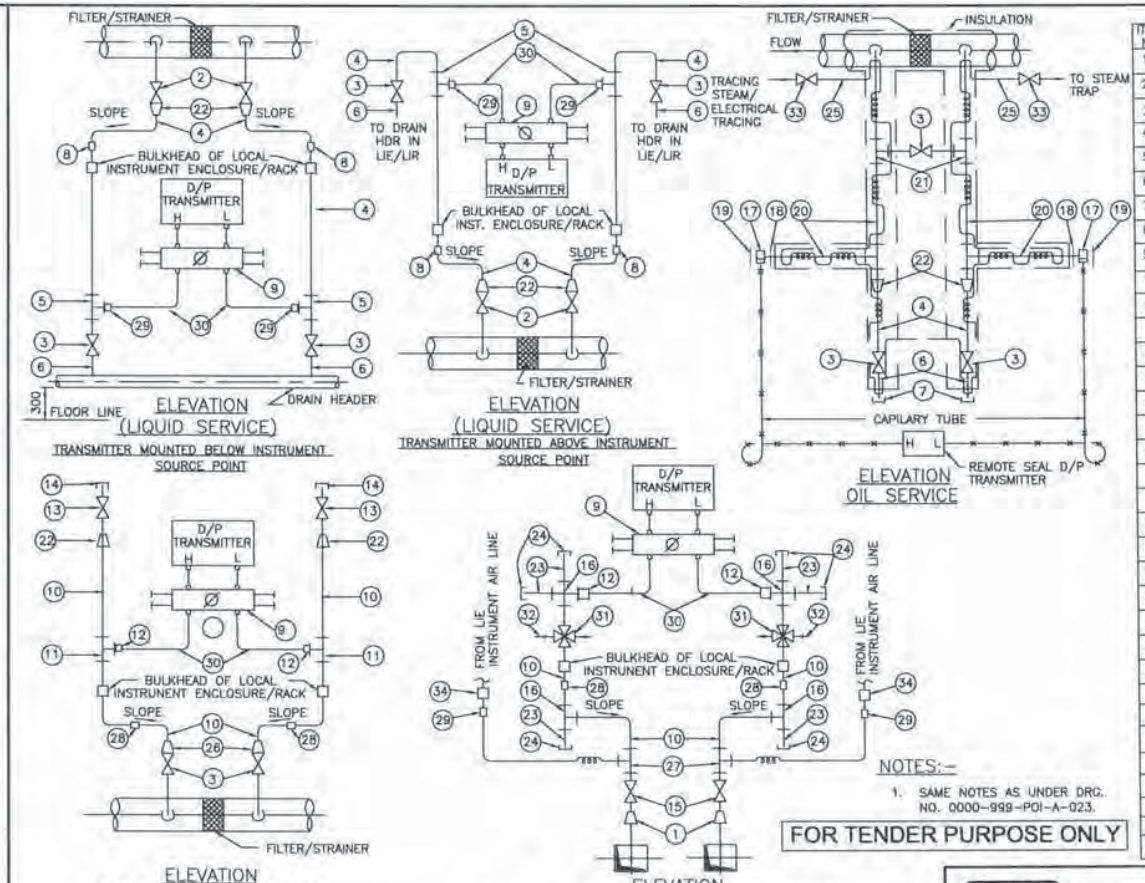

NOTES:-

1. SAME NOTES AS UNDER DRG. NO. 0000-999-POI-A-023.

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LIST OF MATERIALS

ITEM NO.	DESCRIPTION
1.	42x2 TO 3/4" SW REDUCING INSERT.
2.	3/4" SW GLOBE VALVE.
3.	1/2" SW GLOBE VALVE FOR LIQUID APPLICATION & 3/4"/1" IN GAS/AIR APPLICATION.
4.	1/2" NPS 40/80/160 (AS PER PROCESS REQUIREMENT) CARBON/ALLOY STEEL PIPE.
5.	1/2" SW EQUAL TEE.
6.	1/2" NPS SW x 1/2" NPT (M) NIPPLE.
7.	1/2" NPT (F) CAP.
8.	1/2" PIPE x 1/2" PIPE UNION.
9.	5 VALVE MANIFOLD (FOR DETAIL REFER DRAWING NO.0000-999-POI-A-026.
10.	3/4" SCH 80 CARBON/ALLOY STEEL PIPE.
11.	3/4"/1/2" SW EQUAL TEE.
12.	3/4"x1/2" TUBE UNION.
13.	1/2" SCREWED GLOBE VALVE.
14.	1/2" NPT (M) PLUG.
15.	3/4" SW GATE VALVE.
16.	3/4" SW EQUAL CROSS.
17.	WAFER ELEMENT FOR USE WITH 3"ANSI R.F. VALVE.
18.	3"BLIND 300lbs R.F. WELD NECK FLANGE DRILLED FOR 1" SCH. 40/80 PIPE.
19.	3" BLIND FLANGE.
20.	1"NPS SCH. 40/80 (AS PER PROCESS REQUIREMENT) CS PIPE.
21.	1" SW EQUAL TEE.
22.	3/4" x 1/2"SW REDUCING INSERT.
23.	3/4" SW x 3/4" NPT (M) CS/AS NIPPLE
24.	3/4" NPT (F) CS/AS CAP.
25.	1/4" NPS ALLOY STEEL PIPE.
26.	1" x 3/4" SW REDUCING INSERT.
27.	3/4" SW x 1/2" PSW BRANCH TEE.
28.	3/4" PIPE UNION
29.	1/2" CLAMP UNION (THREADED) SUITABLE FOR FLEXIBLE CONNECTION OF NYLON REINFORCED PVC TUBE.
30.	SS TUBE
31.	3/4" SW 4 WAY VALVE.
32.	QUICK DISCONNECT FITTINGS.
33.	1/4" SW ISOLATION VALVE 316SS
34.	1/2" x 1/2" SS PIPE UNION.

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ENGINEERING DIVISION

PROJECT: TYPICAL THERMAL POWER PROJECT

TITLE: INSTRUMENT INSTALLATION DIAGRAM
DIFF. PRESS.MEASUREMENT (LIQUID, OIL, AIR/GAS SERVICE)

REV.NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	E	C	C&I	ARCH.	APPD	DATE
A	FIRST ISSUE						T.G.				21.08.12

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SIZE	SCALE	DRG. NO.	REV. NO.
A3	N.T.S.	0000-999-POI-A-030	A

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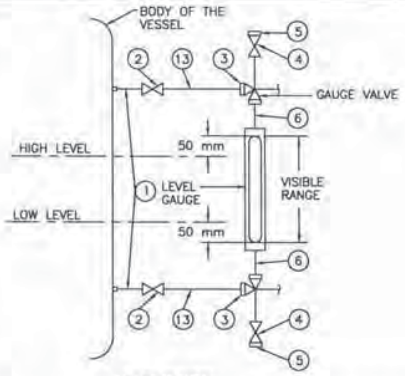
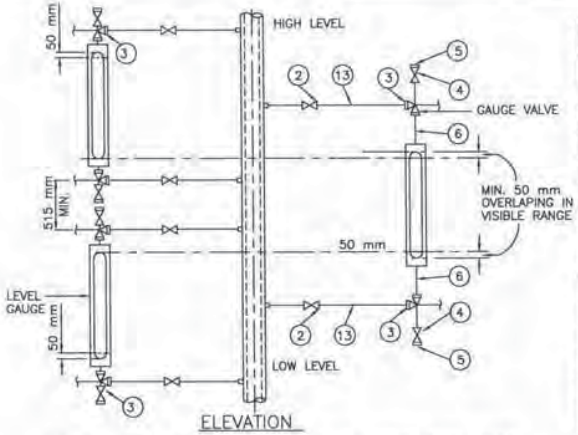


ELEVATION

LOCAL LEVEL INDICATION USING GAUGE GLASS

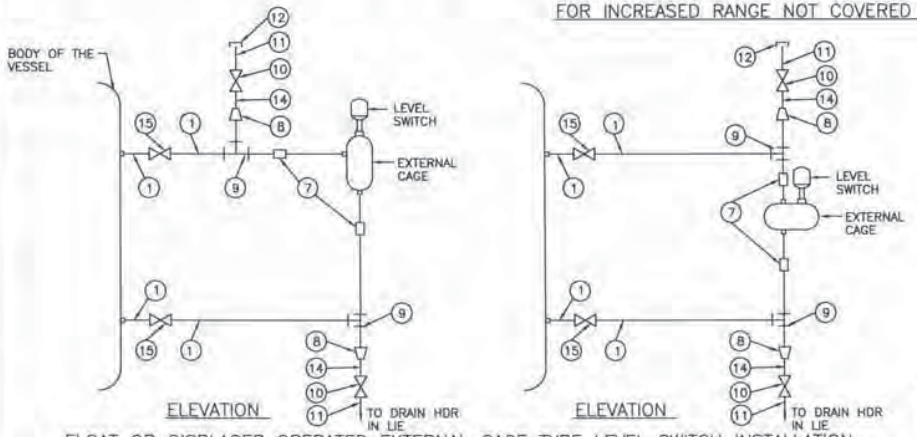


ELEVATION

LOCAL LEVEL INDICATION USING MULTIPLE GAUGES
FOR INCREASED RANGE NOT COVERED IN A SINGLE UNIT

LIST OF MATERIALS

ITEM NO.	DESCRIPTION
1.	3/4"/1" NPS SCH.40/80/160/P91 (AS PER PROCESS REQUIREMENT) CARBON /ALLOY STEEL PIPE.
2.	3/4" SW GLOBE VALVE.
3.	3/4" SW UNION.
4.	3/4" NPT GLOBE VALVE.
5.	3/4" NPT (M) CAP.
6.	3/4" NPT (F) UNION CONNECTION.
7.	1" SW EQUAL UNION.
8.	1" x 1/2" SW REDUCING INSERT.
9.	1" SW EQUAL TEE.
10.	1/2" SW GLOBE VALVE.
11.	1/2" NPS SWx1/2" NPT(M) CS/AS NIPPLE.
12.	1/2" NPT (F) CAP
13.	3/4"x1/2" NPS SCH.40/80 CS/AS PIPE.
14.	1/2" NPS SCH.80/160 CS/AS NIPPLE.
15.	1" SW GLOBE VALVE.



ELEVATION ELEVATION

FLOAT OR DISPLACER OPERATED EXTERNAL CAGE TYPE LEVEL SWITCH INSTALLATION

NOTES:-

1. FOR LEVEL GAUGE 3/4" AND FOR LEVEL SWITCH 1" PROCESS CONNECTION SHALL BE PROVIDED.
2. NOTES UNDER DRG. NO. 0000-999-POI-A-023 (WHICHEVER ARE RELEVENT).

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REV.NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	E	C	C&I	ARCH.	APPD	DATE
A	FIRST ISSUE			T.G.							21.08.12

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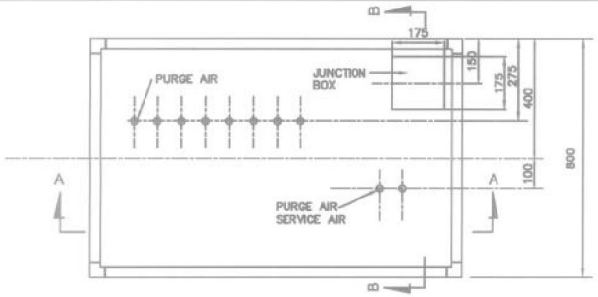
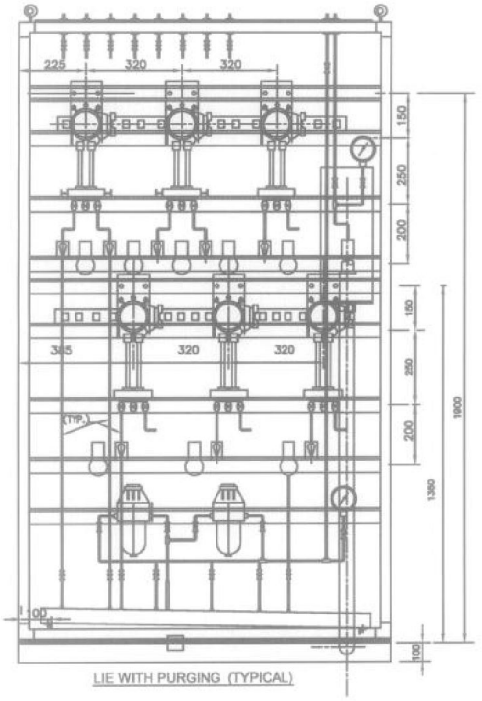
PROJECT: TYPICAL THERMAL POWER PROJECT

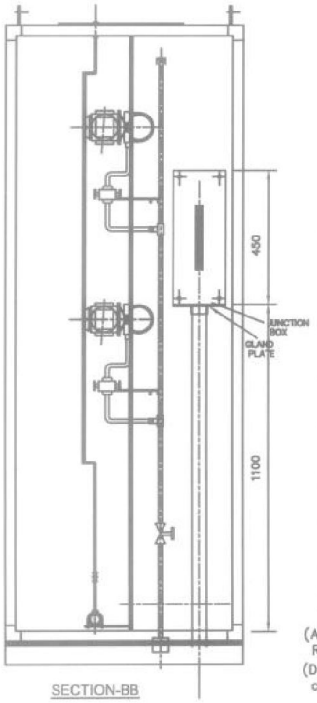
TITLE: INSTRUMENT INSTALLATION DIAGRAM (LEVEL GAUGE & SWITCHES)

SIZE	SCALE	DRG. NO.	REV. NO.
A3	N.T.S.	0000-999-POI-A-031	A





LIE WITH PURGING (TYPICAL)



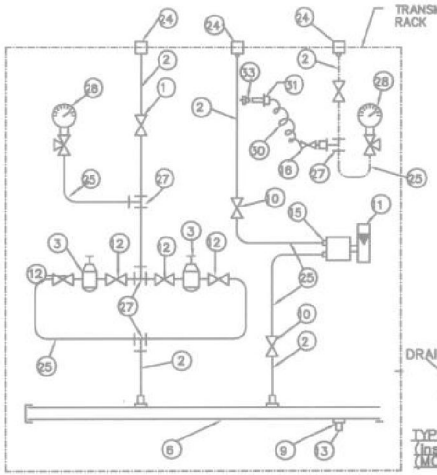
SECTION-BB

LIST OF MATERIALS

ITEM NO.	DESCRIPTION
1.	ISOLATION VALVE(gate/globe). SS.
2.	SEAMLESS SS PIPE.
3.	AIR FILTER REGULATOR.
6.	INST. AIR HEADER SS.
10.	COMP. NEEDLE VALVE SS.
11.	AIR PURGE SET.
12.	COMP VALVE SS.
13.	PLUG SS.
15.	TUBE SS CONNECTOR.
16.	TUBE COMP. EQUAL TEE UNION.
24.	BULKHEAD–SS SUITABLE FOR GI PIPE CONNECTION
25.	SEAMLESS TUBE SS.
27.	BRANCH TEE SS.
28.	PR. GAUGE.
30.	NYLON FLEX. HOSE BRAIDED WITH SS WIRE.
31.	HOSE BARBED CONN. SS.
33.	QUICK DISCONNECT SS (PURGE AIR CONNECTION TO INSTRUMENT SOURCE END).

LIST OF MATERIALS

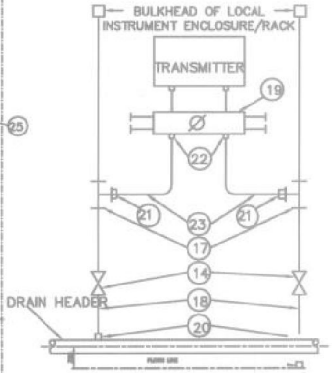
ITEM NO.	DESCRIPTION
14.	SW GLOBE VALVE.
17.	SW EQUAL TEE
18.	S.S. NIPPLE
19.	5 VALVE MANIFOLD
20.	SW HALF COUPLET CS
21.	PIPE x TUBE UNION
22.	SUITABLE ADAPTER
23.	SS TUBE



TYPICAL PURGE AIR CONNECTION INSIDE THE INST. ENCLOSURE

(APPLICABLE FOR MILL, AIR & FLUE GAS SERVICE INSTRUMENTS REQUIRING PURGE AIR)

(Drain Header of each LIE/LIR shall be connected to nearest plant drain)



TYPICAL ARRANGEMENT OF DP TRANSMITTER (Inside LIE/LIR) (MOUNTED BELOW INSTRUMENT SOURCE POINT)

FOR TENDER PURPOSE ONLY

NTPC LIMITED
(A GOVERNMENT OF INDIA ENTERPRISE)
ENGINEERING DIVISION

PROJECT: TYPICAL THERMAL POWER PROJECT (TURNKEY EPC PACKAGE)

TITLE: TYPICAL GA OF LOCAL INSTRUMENT ENCLOSURE, PURGING SCHEME, DP TRANSMITTER

REV.NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	E	C	C&I	ARCH.	APPD	DATE
A	FIRST ISSUE										02.09.11

CLEARED BY

SIZE	SCALE	DRG. NO.	REV. NO.
A2	N.T.S.	0000-999-POI-A-036	A

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PROCESS CONNECTION AND PIPING

1.00.00 **PROCESS CONNECTION PIPING**

1.01.00 The Contractor shall provide, install and test all required material for completeness of Impulse Piping System and Air Piping System as per the requirements of this Sub-Section on as required basis for the connection of all instruments and control equipments of entire plant.

1.01.01 **IMPULSE PIPING, TUBING, FITTINGS, VALVES AND VALVE MANIFOLDS**

1.01.02 All impulse pipes shall be of seamless type conforming to ANSI B36.10 for schedule numbers. The size of impulse pipe shall be ½" for Steam & Water Application and ¾" for Air & Flue Gas applications. The rating of material of impulse pipes, tubes, fittings, valves and their installation thereof shall conform to the latest edition of standards as per following table:

Impulse Pipes, Tubes (Material, Rating)	ANSI B31.1, ANSI B31.1a, ANSI/ISA 77.70
Valves (Material, Pr. Class, Size)	ASTM A182/ASTM A105 as per ASME 16.34
Fittings (Size, Rating, Material)	ANSI B31.1, ANSI B31.1a, ASME B16.11-2009
Installation Schemes	BS 6739-2009, ANSI/ISA 77.70

Stainless steel tube shall be provided inside enclosures & racks from tee connection to valve manifold and then to instrument. The source shut-off (primary process root valve) and blow down valve shall be of 1/2 inch size globe valve type for all applications except for air and flue gas service wherein no source shut-off valves are to be provided. Two root valves are to be used wherever pressure is more than 40 Kg/cm^2 or Temp>280 ^{o}C. The end connections of valves shall be of socket welded type. Typical installation scheme of DP Transmitter (inside LIE/LIR) mounted below instrument source point is indicated in Drg. No. 0000-999-POI-A-036. Same scheme with necessary changes shall be applied for other instruments.

1.01.03 The valve manifolds of 316 SS with pressure rating suitable for intended application shall be provided as given below:

Manifold	Application/Measurement
2 Valve	Pressure measurements using pressure transmitters/pressure switches
3 Valve	Pressure measurements using differential pressure transmitter/ switches
5 Valve	Differential Pressure, Flow and Level Measurements

For Pr./D.P gauges, two-way globe/gate valve shall be provided on each impulse line to the instrument in Fluid/Air & Flue Gas applications respectively .

2.00.00 **AIR SUPPLY PIPING**

2.01.01 All pneumatic piping, fittings, valves, air filter cum regulator, purge rotameter and other accessories required for instrument air for the various pneumatic devices/ instruments shall be provided. This will include as a minimum air supply to pneumatically operated control valves, actuators, instruments, continuous and intermittent purging requirements etc.

2.02.00 Instrument air and Service air supply shall be provided for continuous and intermittent purging respectively for all transmitters of mill, dirty air and flue gas applications. Purging Scheme shall be as per Drg. No. 0000-999-POI-A-036.

2.03.00 The Contractor shall also provide SS Tubing and associated fittings (screwed type) of suitable sizes for all pneumatic equipments/actuators (including supply air, signal air and output to actuators) conforming to ANSI 31.1 and 31.3 standard. All other air supply lines shall be of mild steel hot dipped galvanized inside and outside as per IS-1239, heavy duty

	with threaded ends. Fittings for air supply line shall be of forged carbon steel A234 Gr. WPB galvanized inside and outside, screwed as per ASA B2.1. Dimensions of fittings shall be as per ASA B16.11 of rating 3000 lbs. Air supply piping shall be adequately sloped to prevent accumulation of condensed water within the pipe. The air supply headers, sub-headers and branch pipes shall be supported properly by clamps or supports.
2.04.00	The instrument/service air supply to each equipment/devices requiring air supply shall be provided by a well designed air distribution scheme comprising of 2" GI Pipe Header feeding 1" GI Pipe sub-header feeding ½" pipe at each equipment/device. Instrument air filters cum regulator set with mounting accessories shall be provided for each pneumatic device requiring air supply except for Ash Handling System wherein it shall be provided on instrument air header at each location.
2.05.00	All the isolation valves in the air supply line shall be gate valves as per ASTM B62 inside screw rising stem, screwed female ends as per ASA B2.1. Valve bonnet shall be union type & trim material shall be stainless steel, body rating 150 pounds ASA. The valve sizes shall be ½ inch to 2 inch.
2.06.00	Instrument air filters cum regulator set with mounting accessories shall be provided for pneumatic device requiring air supply. The filter regulators shall be suitable for 10-kg/ sq.cm max. Inlet pressure. The filter shall be of size 5 microns and of material sintered bronze. The air set shall have 2-inch size pressure gauge and built in filter housing blowdown valve. The end connection shall be as per the requirement to be finalized during detailed engineering.
3.00.00	**INSTALLATION AND ROUTING**
3.01.01	All instrument piping, tubing and its accessories shall be supported in a safe manner to prevent excessive vibrations and anchored sufficiently to prevent undue strain on connected equipment. Impulse piping shall be supported at an interval not exceeding 1.5 meters. The slope of the impulse pipe form the process connection to the instrument shall be as per ANSI/ISA 77.70 latest edition and BS 6739-2009. All impulse piping shall be installed to permit free movement due to thermal expansion. Wherever required expansion loops shall be provided. Condensate pots shall be provided for all level measurements in steam and water services, all flow measurement in steam services and for flow measurements in water services above 120 Deg. C. Colour coding of all impulse pipes shall be done by the Contractor in line with the colour coding being followed for the parent pipes.
4.00.00	**SHOP AND SITE TESTS**
4.01.01	The equipment and work performed as per this Sub-section shall be subject to shop and site test as per requirements of Sub-section-IIIE-04 (Quality Assurance & Inspection) other applicable clauses of this Sub-section and Employer approved quality assurance plan.
4.01.02	Hydrostatic and Pneumatic leakage tests shall be performed on all pipes, tubing and systems and shall conform to ANSI B31.1.
5.00.00	**LOCAL INSTRUMENT ENCLOSURE AND RACKS** All transmitters, switches etc. in Boiler Turbine Generator measurements (except for all fuel oil applications) shall be suitably grouped together and mounted inside (i) local instruments enclosures in case of open areas of the plant like boiler area, etc. and (ii) In local instrument racks in case of covered areas like Turbine/Generator area. The GA of LIE with purging indicated in the Drg. No. 0000-999-POI-A-036 is to be followed by contractor. The GA of LIR shall be similar to LIE except for front/rear doors and side panels.

.

The internal layout shall be such that the impulse piping/ blow down lines are accessible from back side of the enclosure / rack and the transmitters etc. are accessible from front side for easy maintenance. Bulkheads, especially designed to provide isolation from process line vibration shall be installed on instrument enclosures/racks to meet the process sensing line connection requirement. Vibration dampeners shall be installed for each enclosure / rack. The Degree of Protection of LIE and JB of LIE/LIR shall be IP-55.

The instrument racks shall be free standing type constructed of suitable 3 mm thick channel frame of steel and shall be provided with a canopy to protect the equipment mounted in racks from falling objects, water etc. The canopy shall not be less than 3 mm thick steel, and extended beyond the ends of the rack.

Enclosures/Racks shall be reinforced as required to ensure true surface and to provide adequate support for instruments and equipment mounted therein. Centre posts or any member which would reduce access shall not be provided.

Contractor shall provide not more than three variants for LIE/LIR with respect to max. no. transmitters mounted in each LIE/LIR.

5.01.00 ENCLOSURE / RACKS FOR DUAL I/P TEMPERATURE TRANSMITTERS

All Dual Input temperature transmitters in Boiler Turbine Generator measurements shall be suitably grouped together and mounted inside (i) Enclosures in case of open areas of the plant like boiler area, etc. and (ii) Racks in case of covered areas like Turbine/Generator area. Integral JB shall be provided with each Enclosure and Rack.

The internal layout shall be such that the transmitters are accessible from both front and back side of the enclosure / rack for easy maintenance.

Enclosure/ Racks shall be of robust and rugged design. Vibration dampeners shall be installed for each enclosure / rack. The Degree of Protection of Enclosure and JB shall be IP-55.

Enclosure and Racks shall be free standing type.

Enclosures/Racks shall be reinforced as required to ensure true surface and to provide adequate support for instruments and equipment mounted therein.

Contractor shall provide not more than five variants for Enclosure/ Rack with respect to max. no. transmitters mounted in each Enclosure/ Rack. However, the maximum number of Transmitters that can be grouped in one Enclosure/ Rack shall be decided during detail Engineering.

6.00.00 **INSTALLATION OF OTHER INSTRUMENTS:**

For installation and routing of other field mounted instruments which are not covered in Cl. No. 5.00.00, please refer Cl. No 52.04.00(f) of Section-VI, Part-D, Erection Conditions of Contract (ECC) of Technical Specifications.

CABLE INTERCONNECTION AND TERMINATION PHILOSOPHY

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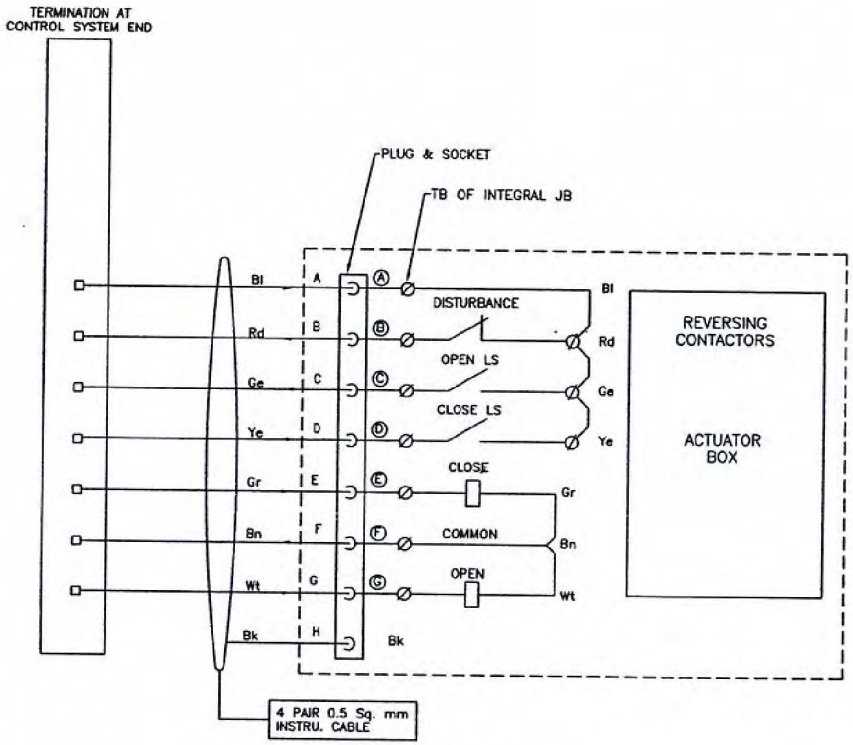

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NTPC LIMITED
(A GOVERNMENT OF INDIA ENTERPRISE)
ENGINEERING DIVISION

PROJECT: TYPICAL THERMAL POWER PROJECT

TITLE: INTERFACING OF ACTUATORS

REV.NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	E	C	C&I	ARCH.	APPD	DATE
A	FIRST ISSUE										28.04.06

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SIZE	SCALE	DRG. NO.	REV. NO.
A3	N.T.S.	0000-999-POI-A-063	A

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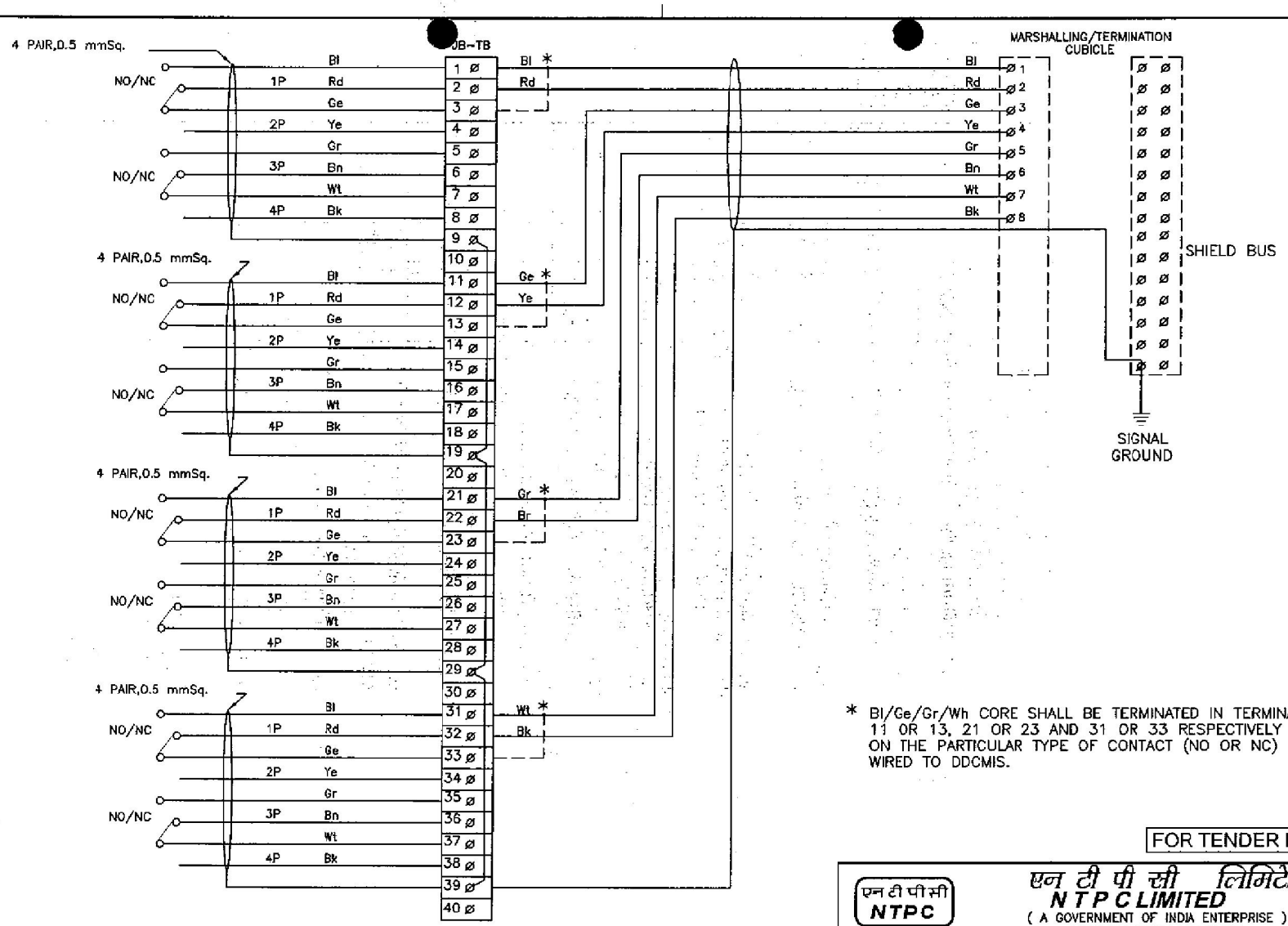

* Bl/Ge/Gr/Wh CORE SHALL BE TERMINATED IN TERMINAL 1 OR 3, 11 OR 13, 21 OR 23 AND 31 OR 33 RESPECTIVELY DEPENDING ON THE PARTICULAR TYPE OF CONTACT (NO OR NC) IS TO BE WIRED TO DDCMIS.

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NTPC LIMITED
(A GOVERNMENT OF INDIA ENTERPRISE)
ENGINEERING DIVISION

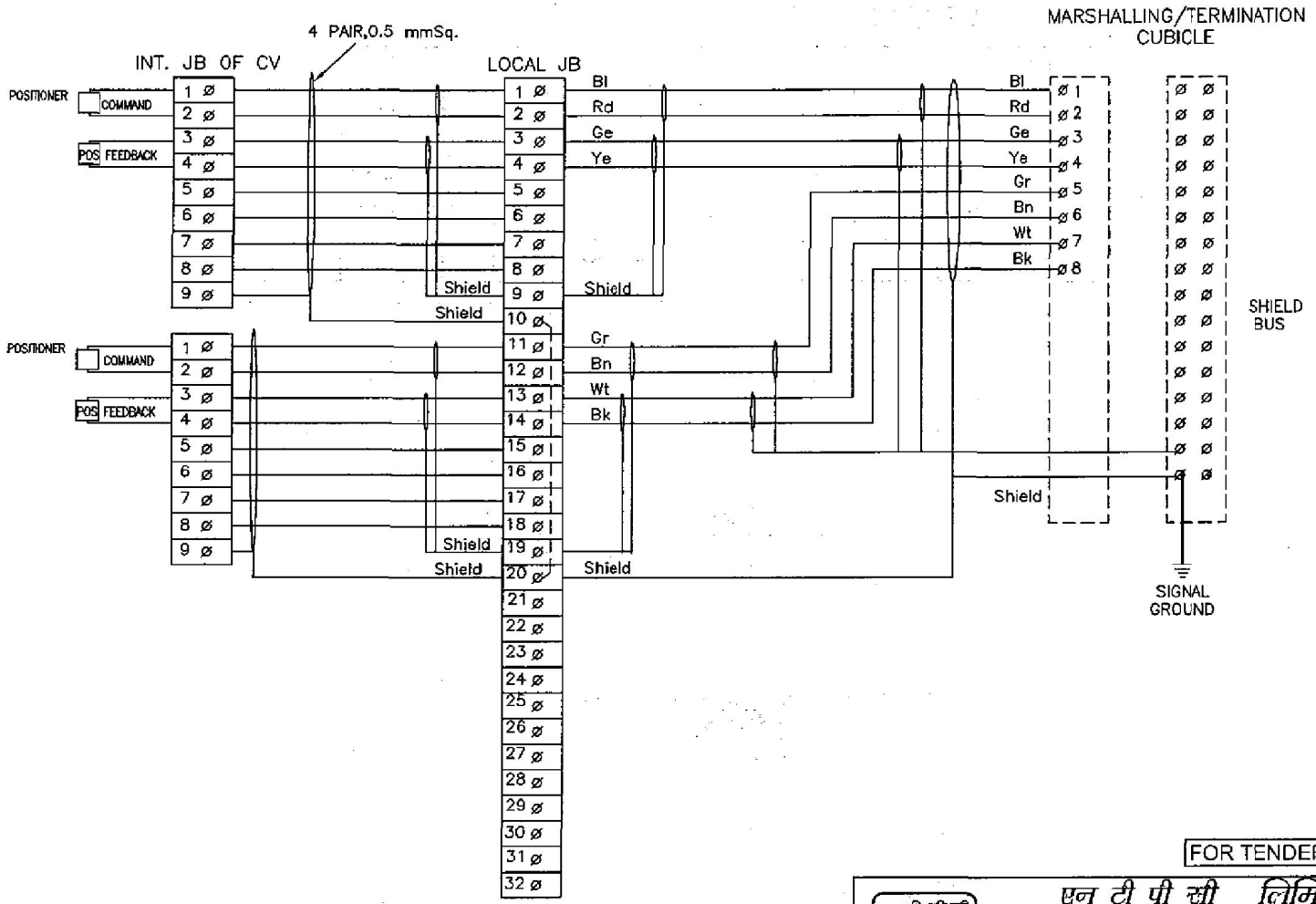
PROJECT: TYPICAL THERMAL POWER PROJECT

TITLE: INTERFACING OF FIELD INSTRUMENTS
SWITCH TERMINATION DETAILS
NO/NC

REV.NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	E	C	C&I	ARCH.	APPD	DATE
A	FIRST ISSUE										29.04.08

CLEARED BY.

SIZE	SCALE	DRG. NO.	REV. NO.
A3	NTS	0000-999-POI-A-065 SH 02 OF 14	A



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FOR TENDER PURPOSE ONLY

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NTPC LIMITED
(A GOVERNMENT OF INDIA ENTERPRISE)
ENGINEERING DIVISION

PROJECT: TYPICAL THERMAL POWER PROJECT

TITLE: INTERFACING OF FIELD INSTRUMENTS CONTROL VALVE

REV.NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	E	C	C&I	ARCH.	APPD	DATE
A	FIRST ISSUE										29.04.06

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SIZE	SCALE	DRG. NO.	REV. NO.
A3	NTS	0000-999-POI-A-065 SH 03 OF 14	A

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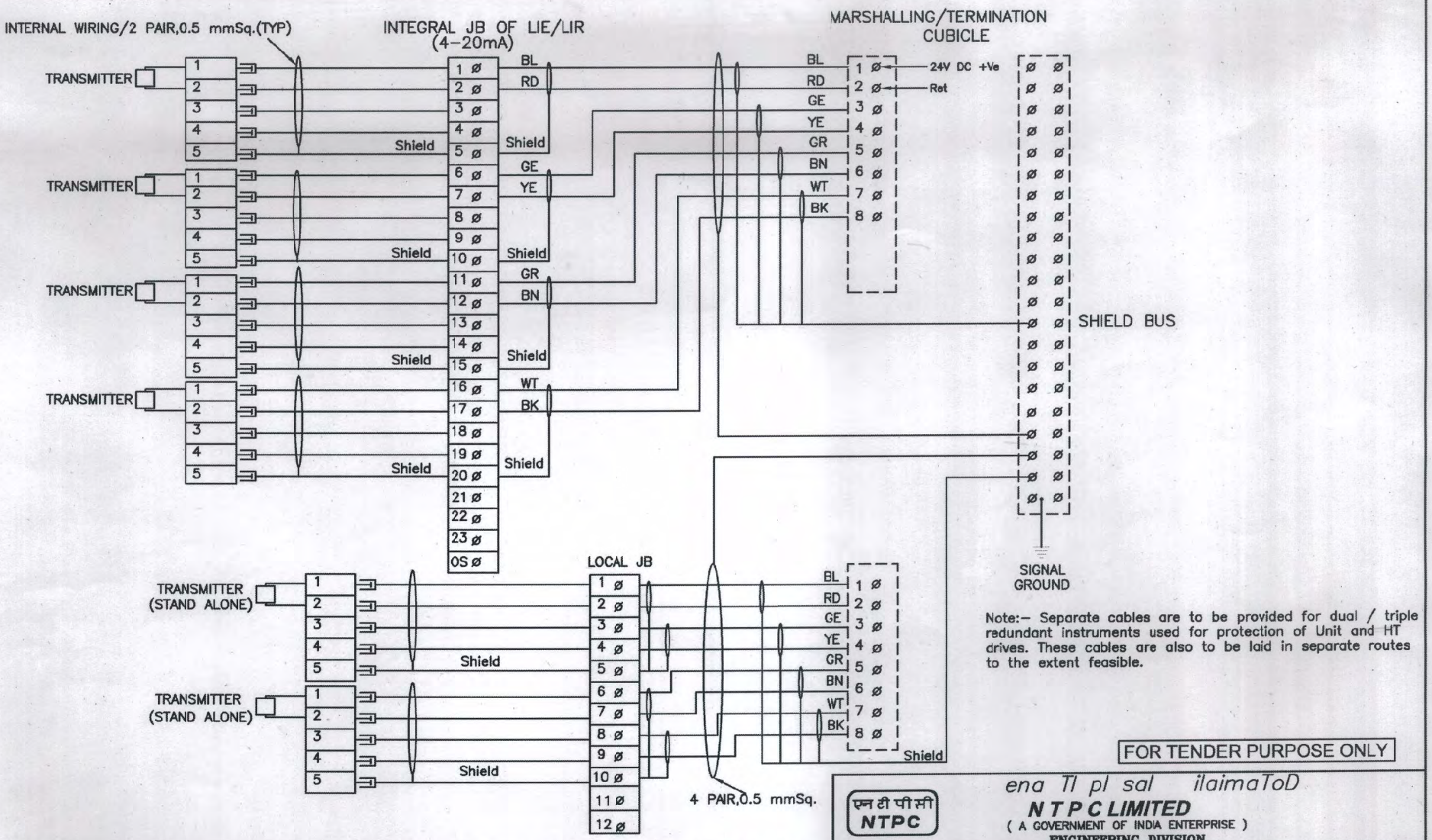

Note:– Separate cables are to be provided for dual / triple redundant instruments used for protection of Unit and HT drives. These cables are also to be laid in separate routes to the extent feasible.

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REV.NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	E	C	C&I	ARCH.	APPD	DATE
C	NOTE REGARDING CABLE IS ADDED.										10.12.13
B	INTERNAL WIRING FOR LIE/LIR MOUNTED SHOWN WIRING OF STAND ALONE TXTR SHOWN										10.12.06
A	FIRST ISSUE										12.1.05
					CLEARED BY						

PROJECT: TYPICAL THERMAL POWER PROJECT

TITLE: INTERFACING OF FIELD INSTRUMENTS 4-20mA

SIZE	SCALE	DRG. NO.	REV. NO.
A3	NTS	0000-999-POI-A-065 SH 04 OF 14	C

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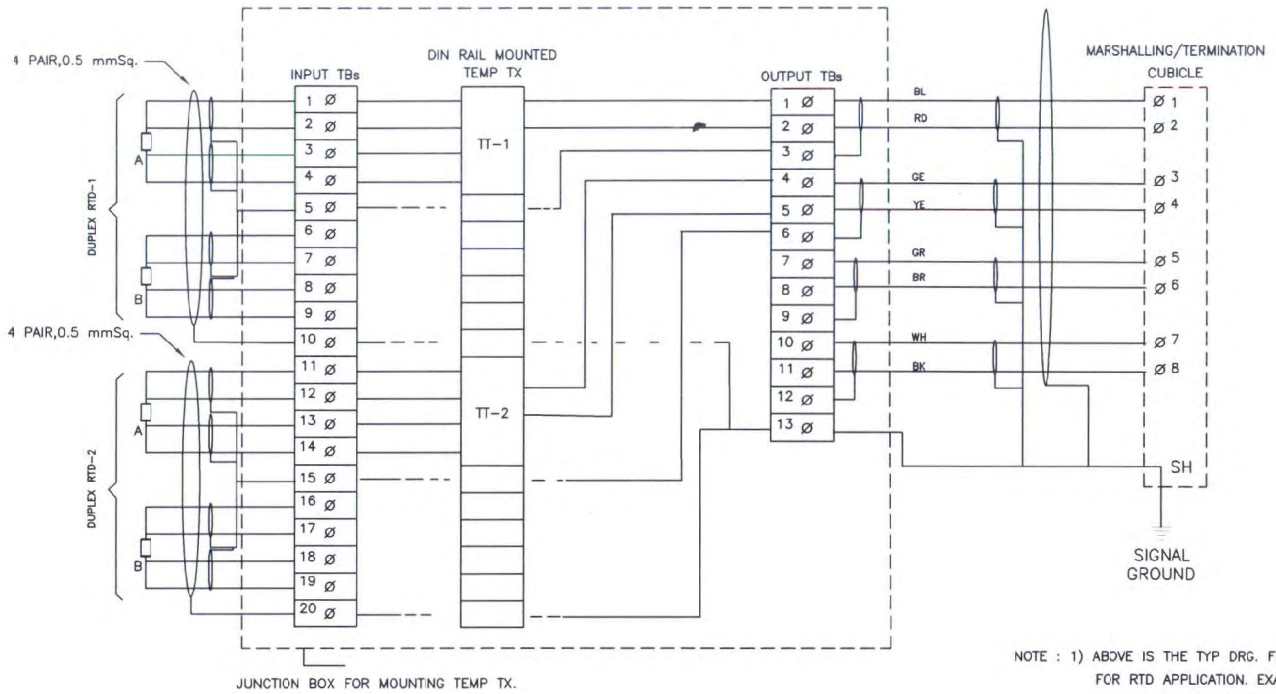

NOTE : 1) ABOVE IS THE TYP DRG. FOR DIN RAIL MOUNTED TEMP TRANSMITTERS FOR RTD APPLICATION. EXACT TYPE OF TEMP TRANSMITTER SHALL BE AS PER PART-A OF SPECIFICATION.

2) THE EXACT GROUPING OF TEMP TXs SHALL BE FINALISED DURING DETAILED ENGG. STAGE.

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N T P C LIMITED
(A GOVERNMENT OF INDIA ENTERPRISE)
ENGINEERING DIVISION

PROJECT: TYPICAL THERMAL POWER PROJECT

TITLE: INTERFACING OF FIELD INSTRUMENTS
TYPICAL RTD CONNECTION WITH TEMP TRANSMITTERS INJBs

REV.NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	E	C	C&I	ARCH.	APPD	DATE
A	FIRST ISSUE		PKE								29.04.06

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SIZE	SCALE	DRG. NO.	REV. NO.
A3	NTS	0000-999-POI-A-065 SH 06 OF 14	C

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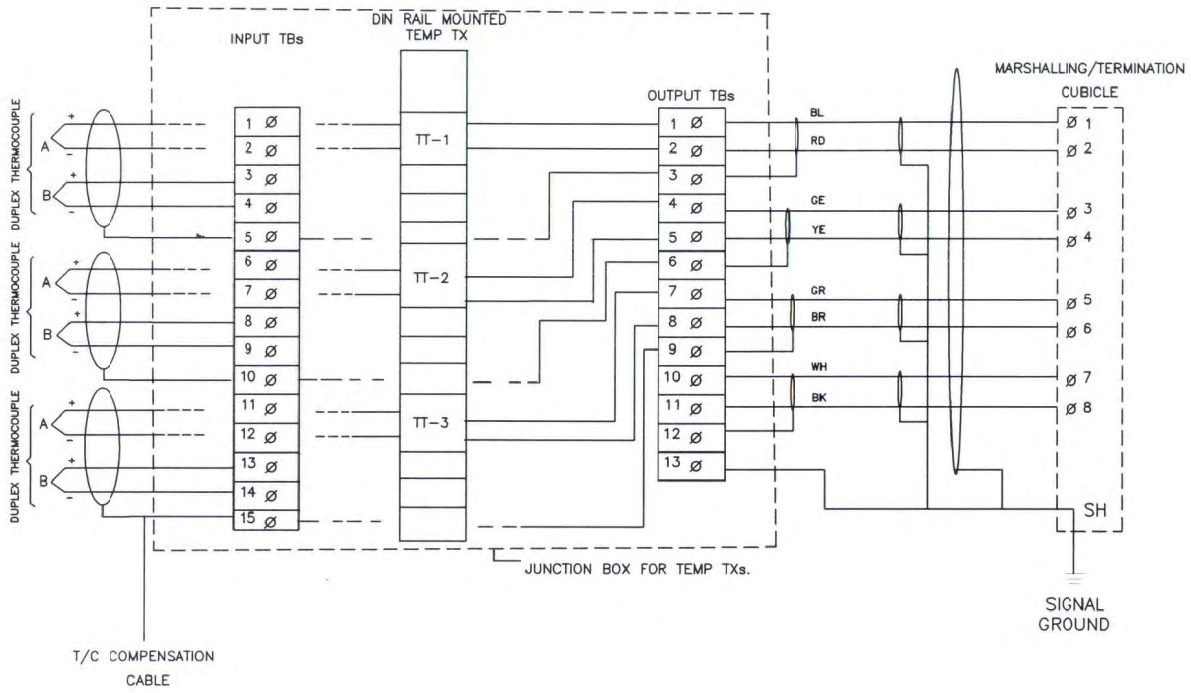

NOTE: 1) ABOVE IS THE TYP DRG. FOR DIN RAIL MOUNTED TEMP TRANSMITTER FOR T/C APPLICATION. EXACT TYPE OF TEMP TRANSMITTERS SHALL BE AS PER PART-A OF SPECIFICATION.

2) THE EXACT GROUPING OF TEMP TXs SHALL BE FINALISED DURING DETAILED ENGG. STAGE.

3) AFTER GLANDING OF T/C CABLES ON JB, THE CABLE PAIR OF FIRST ELEMENT WILL BE DIRECTLY CONNECTED TO TT AND FOR CABLE PAIR OF SECOND ELEMENT LOOP SHALL BE KEPT, BEFORE TERMINATION AT INPUT TBs FOR FUTURE USE.

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N T P C LIMITED
(A GOVERNMENT OF INDIA ENTERPRISE)
ENGINEERING DIVISION

REV.NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	E	C	C&I	ARCH.	APPD	DATE
A	FIRST ISSUE										29.04.06

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PROJECT: TYPICAL THERMAL POWER PROJECT

TITLE: INTERFACING OF FIELD INSTRUMENTS
TYPICAL T/C CONNECTION WITH TEMP TXs IN JBs

SIZE	SCALE	DRG. NO.	REV. NO.
A3	NTS	0000-999-POI-A-065 SH 11 OF 14	C

MANDATORY SPARES

CONTROL & INSTRUMENTATION-PT PLANT

Sl. No.	ITEM	QUANTITY
1.00.00	**MEASURING INSTRUMENTS**	
1)	Electronic Transmitters	
(i)	Transmitters of all types and model. (for the measurement of Pressure, differential pressure, flow, level, etc.) including local indication (if applicable)	10 % or 1 no. of each type and model whichever is more
2)	Temperature elements	
(i)	Temperature Transmitter	10 % or 1 no. of each type and model whichever is more
(ii)	RTD's*	1 no. of each type
(iii)	Thermo well	1 no. of each type
	* (With head assembly, terminal block and nipple)	** (to be divided into various insertion lengths in proportion to main population)
3)	Local Indicators (Non-Electrical type) -As applicable for the package as per the following items	
(i)	Temperature gauges	1 no. of each range and type
(ii)	Pressure gauges	1 no. of each range and type
(iii)	Differential Pressure Gauges,	1 no. of each range and type
(iv)	Level gauges	1 no. of each range and type

Sl. No.	ITEM	QUANTITY
(v)	Flow gauges excluding Rota meters	1 no. of each range and type
(vi)	All types of Rota meters	1 no. of each range and type
4)	Process Actuated Switch Devices -As applicable for this package, as per the following items	
(i)	Temperature switches	1 no. of each range and type
(ii)	Pressure switches	1 no. of each range and type
(iii)	Differential Pressure switches	1 no. of each range and type
(iv)	level switches	1 no. of each range and type
(v)	Flow switches	1 no. of each range and type
5)	Solenoid Valves	10 % or 1 no. of each type and model whichever is more
6)	Limit Switches (for Pneumatic Valves and Manual valves)	2 no. of each type
7)	ANALYSERS	
1)	PH Analyzer	
	(a) Flow Through type cell and Electrode	1 no of each type
	(b) Electronic Transmitter unity without sensor	1 no of each type
	(c) Pre-fabricated cable with connector	1 set
2)	Conductivity Analyzer	
	(a) Flow Through type cell and Electrode	1 no of each type
	(b) Electronic Transmitter unity without sensor	1 no of each type
	(c) Pre-fabricated cable with connector	1 set
3)	Turbidity Analyzer	
	(a) Flow Through type cell and Electrode	1 no of each type
	(b) Electronic Transmitter unity without sensor	1 no of each type
	(c) Pre-fabricated cable with connector	1 set

Sl. No.	ITEM	QUANTITY
4)	Residual Chlorine Analyzer (a) Sensor (b) Transmitter (c) Pre-fabricated cable with connector (d) All Chemical Reagents for 12 month operation (Supply to be staggered as per the shelf life)	1 no of each type 1 no of each type 1 set 1 set
2.00.00	**PROCESS CONNECTION PIPING (FOR IMPULSE PIPING/TUBING, SAMPLING PIPING/TUBING AND AIR SUPPLY PIPING AS APPLICABLE)**	
1)	2 way, 3way, 5way valve manifolds	1 no. of each type, class, size and model

KKS TAGGING PHILOSOPHY

KKS NUMBERING PHILOSOPHY

For identifying (tagging) an instrument / equipment in Power plant KKS numbering scheme is used. The purpose is to assign a unique number to every equipment in the power plant. For C&I equipment unique number are to be provided up to the signal level so that a unique number Input / Output exist in DCS for every signal.

Normally KKS number is a 10 digit alpha-numeric code and is typically split into the following:

X	X	X	A	A	Y	Y	B	B	B

First three digits indicate the Sub-System. The Code for the major system are given as per **Annexure-**1.

Fourth and Fifth digits are the **Numerical Keys at System Code Level** and used to distinguish between main systems having same Alpha Codes.

Sixth and Seventh digits are the **Equipment / Apparatus / Measuring Circuit Code**. The code of various Equipment / Apparatus / Measuring Circuit is shown in **Annexure-2**

Eight, Nine and tenth digits are the **Numerical Keys at Equipment / Apparatus / Measuring Circuit Code** and used to distinguish between various instruments in the same sub-group. Numerical keys at System / Equipment / Apparatus / Measuring Circuit is shown in **Annexure-3**.

**

KKS TAGS ARE ALREADY PROVIDED IN THE P&ID FURNISHED BY BHEL.HOWEVER, IF THE KKS NUMBER OF EQUIPMENT/INSTRUMENTS CHANGES, THE KKS FOR THE SAME SHALL BE FINALIZED DURING DETAILED ENGINEERING.

ANNEXURE-1

List of System / Sub-System Codes used in Power Plant:

1) Refer the P&ID sheets.

ANNEXURE-2

Standard Equipment Codes:

AA	Valves including drives, also hand operated
AB	Seclusions, Lock, Gates, Doors
AC	Heat Exchanger
AE	Turning, Driving, Lifting equipment
AF	Continuous conveyors, Feeders
AG	Generator Units
AH	Heating and Cooling Units
AK	Pressing and Packaging equipment
AM	Mixer, Stirrer
AN	Blower, Air Pumps / Fans, Compressor Units
AP	Pump Units
AT	Purification, Drying, Filter
AV	Combustion Equipment e.g. grates

Standard Apparatus Codes:

BB	Vessels and Tank
BF	Foundation
BG	Boiler Heating Surfaces
BN	Injector, Ejector
BP	Flow and throughput limitation equipment (Orifice)
BQ	Holders, Carrying Equipment, Support
BR	Piping, Ducts, Chutes, Compensator
BS	Sound Absorber
BU	Insulations, Sheatings

Standard Measuring Circuits Codes:

CD	Density
CE	Electrical Quantities
CF	Flow, throughput
CG	Distance, Length, Position
CK	Time
CL	Level

CM	Humidity
CQ	Analysis (SWAS)
CS	Speed, Velocity, Frequency
CT	Temperature
CY	Vibration, Expansion

ANNEXURE-3

Numerical Keys

A) Numerical Keys at System Code Level

i) Use 10, 20, 30... To distinguish between main systems having same Alpha Codes. Examples:

a) Main Steam (Left) and Main Steam (Right)

b) BFP – A/B/C

c) ID Fan – A/B, FD Fan A/B, AH – A/B

ii) For branch off from main system path having code say 10, keep the same alpha code and use 11, 12, 13 etc. Similarly for other branch off from main system path having code say 20, keep the same alpha code and use 21, 22, 23 etc and shall carry on further in the same way.

iii) If the branch off from main system / sub system path is used for some other system, where different alpha codes can be applied, then in that case the said branch line will be designated by the alpha codes of the system to which it is providing the input.

B) Numerical keys at Equipment Code level:

There are three numerical keys available for each type of equipment code. Following has been agreed upon considering present practice, better flexibility and ease in sorting.

i) Valves and Dampers --- *Equipment Code – AA*

		N1	N2 N3
Motorised *(on/off duty)*	-	*0*	*01 to 50*
Motorised (inching duty)	-	*0*	*51 to 99*
Pneumatic (Control)	-	*1*	*01 to 50*
Motorised (thyrestor Control)	-	*1*	*51 to 99*
Sol. Operated	-	2	01 to 99
(Open / Close duty (Valves, NRVs, Gate)			
Hydraulic	-	3	01 to 99

NRV (Without actuation)	-	4	01 to 99
Manual	-	5	01 to 99
Manual	-	6	01 to 99
Relief & Safety Valves	-	7	01 to 99
Reserve	-	8	01 to 99
Reserve	-	9	01 to 99

ii) Field Instruments

Field Transmitters & Analog Signals	-	0	01 to 99
Field Switches & Binary Signals	-	1	00 to 99
PG Test Point	-	4	00 to 99
Gauges	-	5	00 to 99
Automatic Turbine Tester (ATT)-HWR	-	2	00 to 99
(Reserved for protection Signals used by Hardwar)			

Example of Numerical Key Usage:

In line with the philosophy adopted for Valves / Dampers /instruments etc. pumps and fans in the main systems (having different system code) can be numbered as AP/N100 and as AP/N101, 102, ……. Where system code is same.

SECTION-C4
(SPECIFIC TECHNICAL REQUIREMENT-CIVIL)

1.0 SCOPE OF CIVIL WORK

Total Civil works (excluding chemical house & Centrifuge Shed) is in bidder's Scope of work. The scope includes complete analysis ,design, supply of cement, steel (reinforcement, structural etc.),aggregate, coarse sand/sand and add mixtures and any other material required for completion of civil work, construction, erection of all civil structural & architectural works of complete pretreatment plant area including but not limited to excavation, backfilling, encasing of pipes, foundation of equipment, brick work, plastering, PCC, painting, shuttering, Pipe & cable pedestal, associated walkways, pathways, interconnecting platforms, handrails, staircases, plinth protections, peripheral drains, acid & alkali resistance tiling/bricks, paintings for civil structures, material required for grouting of equipment foundations, fixing and any concreting inside the vessels and lining, any other material as specified elsewhere in the specification.

The civil works including operating / maintenance platforms and interconnection platforms (if any) with ladders / stairs & handrails, structural supports and hangers for pipes / cables / ducts, crane rails, all embedment's and inserts with lugs including anchor fasteners, bolts etc., dressing of foundations, grouting of pockets and underpinning of base plates for equipment / structures and fixing supports, filling and finishing of openings in walls, floors, cladding, roof and trenches shall be in bidder's scope.

The RCC to be considered is M30 grade & The reinforcement including bar bending to be considered as Fe500/Fe5000D.

Bidder to consider the following but not limited to major items of PT plant excluding Chemical house and centrifuge shed.

- PT (ACW & Potable System)-Aerator, Stilling Chamber, parshall flumes, Interconnecting channels, Bypass Channels, Inlet chambers, telescopic chambers etc.
- PT (DM System)-Aerator, Stilling Chamber, parshall flume, Interconnecting channels, Bypass Channel, Inlet chamber, telescopic chambers etc.
- PT (ACW & Potable System)-Clarifiers, outlet channels up to clarified water storage tank & Gravity Filer-Potable water etc.
- PT (DM System)-Clarifier, outlet channel up to Gravity Filer-DM, etc.
- Gravity Filer House (PT-Potable & PT DM), including piping gallery house, filter water reservoirs, Filtered water pump house etc.
- Common Sludge Pit For PT- CW,DM & lamella Clarifier including inlet & outlet chambers etc.
- Filter backwash waste collection pit including inlet & outlet chambers.
- Thickened waste sump including inlet & outlet chambers.
- Foundation of PAC storage tanks, Unloading Pumps, Dyke area along with acid alkali resistance tiling/Lining.
- Foundation of equipment, Pipe & cable pedestals, associated walkways, pathways, interconnecting platforms, RCC staircases, plinth protections, peripheral drains along with cover, filling and finishing of openings in walls, floors, cladding, roof and cable trenches along with cover etc for the complete pretreatment plant as per technical specifications.

During Civil design while furnishing the drawing /design for BHEL's & Customer Review/approval, Bidder shall furnish the designed quantiles of Reinforcement steel & Cement in Drawing/Documents.

Disposal Point of Surplus Earth/Soil

Bidder to consider distance of disposal area from PTP plant 4KM approx.

Contractor shall read the parts of the specification relevant to PT pant and ETP and shall ignore the other parts of the specification. Relevant clauses of this section as applicable for PT pant and ETP to be followed.)

NTPC Limited

(A Government of India Enterprise)

PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)

TECHNICAL SPECIFICATION

FOR

EPC PACKAGE

PART – B (CIVIL)

(BOOK 4 OF 6)

SECTION - VI

BIDDING DOCUMENT NO.: CS:9585-001-2

NTPC Limited

(A Government of India Enterprise)

PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)

TECHNICAL SPECIFICATION

FOR

EPC PACKAGE

PART – B (CIVIL)

(BOOK 4 OF 6)

SECTION - VI

BIDDING DOCUMENT NO.: CS:9585-001-2

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1.00.00 **GENERAL**

1.01.00 This specification is to cover, survey works , site leveling works, design, preparation of general arrangement drawings, construction and fabrication drawings, supply of labour& materials and construction of all civil, structural and architectural works by the Bidder.

Description of various items of work under this specification and nature of work in detail are given hereinafter. The complete work under this scope is referred to as civil works. Various buildings, structures, plant and systems, facilities, etc., covered under the scope is given in Part-A and herein.

The work to be performed under this specification consists of design, engineering, construction, erection and providing all labour, materials, consumables, equipment, temporary works, temporary storage sheds, temporary colony for labour and staff, temporary site offices, constructional plants, fuel supply, transportation and all incidental items not shown or specified but reasonably implied or necessary for the completion and proper functioning of the plant, all in strict accordance with the specifications including revisions and amendments thereto as may be required during the execution of work.

All construction materials including cement, reinforcement steel, coarse & fine aggregate, structural steel and construction water etc., shall be arranged by the Bidder.

The scope shall also include setting up by the Bidder a complete testing laboratory in the field to carry out all relevant tests for structural steel, reinforcement steel & reinforced concrete (RCC) works.

Preliminary geotechnical investigation in the proposed area has been carried out by the Owner and theborelog data is furnished in Annexure 'C'. Detailed Geotechnical Investigation shall be carried out by the bidder. The foundation system shall be evaluated by the bidder based on the above mentioned detailed geotechnical investigation.

The work shall be carried out according to the design/drawings to be developed by the Bidder and approved by the Employer. For all buildings, facilities, systems, structures, etc., necessary layout and details are to be developed by the Bidder keeping in view the statutory and functional requirements and providing enough space and access for operation, use and maintenance. The Bidder's work shall cover the complete requirements as per IS codes, fire safety norms, requirements of various statutory bodies, International Standards, best prevailing practices and to the complete satisfaction of the Employer.

The Bidder shall make the layout and levels of all structures from the general grid of the plot and the nearest GSI benchmark or other acceptable benchmark of Govt. deptt. As per the directions of the Engineer. The Bidder shall be solely responsible for the correctness of the layout and levels and shall also provide necessary instruments, materials, access to works, etc., to the Engineer for general checking of the correctness of the civil works.

All the quality standards, tolerances, welding standards and other technical requirements shall be strictly adhered to.

The Bidder shall fully apprise himself of the prevailing conditions at the proposed site, climatic conditions including monsoon pattern, soil conditions, local conditions and site specific parameters and shall include for all such conditions and contingent measures in the bid, including those which may not have been specifically brought out in the specifications.

In case of any conflict between stipulations in various portions of the specification, most stringent stipulation would be applicable for implementation by the Bidder without any extra cost to the Employer.

Wherever there is an anomaly in the design concept between the data furnished in the General Design Criteria & Design Concept of Buildings, the data furnished in the design concept of buildings shall be treated as final.

Bidder or his agencies engaged as detailer for fabrication drawings should have the experience of detailing for power house structures or steel plant or Industrial structures like Petro/Chemical/Refinery/Cement Etc.

Bidder shall obtain the approval of detailing agency for making fabrication drawings before engaging them.

2.00.00 SCOPE OF WORK

2.01.01 The scope of work for the EPC contractor shall include the analysis, design, construction, erection of all civil, structural & architectural works and all other items mentioned in Part-A of this Specification.

2.02 Construction Facilities

For details of construction facilities refer to Part-A of this specification.

2.03 Exclusions:

The details of exclusions and terminal points, refer to Part-A of this specification.

3.00.00 SUBMISSIONS

3.00.01 The documents and drawings as listed below are to be submitted for the approval of the Employer unless specified otherwise. The list given below is not exhaustive but indicative only.

Project design intent document giving the basis of design, which shall cover all the aspects, parameters, assumptions, references, structural idealization / mathematical model, loading cases, load combinations, basis of analysis and design of all buildings, facilities, systems and structures etc. shall be furnished and got approved before commencement of detailed engineering.

a) Structural analysis, design calculations and drawings of substructure and super structures for all buildings, structures, facilities, and systems. Analysis, design calculations and drawings for all services like roads, culverts, bridges, road/rail crossings, drainage pump houses (if required), drains, sewers, sewage pump house, water supply, water tank, coal conveyor galleries, trestles, transfer points, trenches, ducts, etc.

b) Survey drawings indicating spot levels for the area under the scope of work and L-section along pipe corridors outside plant boundary.

c) Plant'General Layout Plan' drawing with coordinates of roads, boundary wall, buildings and facilities, piping/cable corridors, railway lines, green belt, etc.

d) Drawings showing underground facilities with co-ordinates and invert levels of the facilities like buried pipes, buried cables, trenches, ducts, sewers, drains, sumps, pits, culverts, manholes, etc.

e) **Bidder shall engage a specialized architect consultants with experience in different design aspects like architecture, interior design & landscape design. The consultant shall be involved in the overall Architectural design and Character of the buildings. However detailing work of the individual buildings may be done by In-house architects having adequate experience**. The consultant shall evolve the design based on employer's guidelines and shall present it in the form of Presentation Drawings, Detail Drawings, Perspective View& 3D Model/ Walk through. All drawing and document shall be duly stamped by the Registered Architect

h) All architectural drawings required for execution of construction work such as detail floor plans, detail elevations, detail sections and other miscellaneous architectural details such as finish schedule(internal & external), colour schemes (both internal and external), doors and windows, flooring details &pattern,Atrium Vault/ Dome in polycarbonate sheet in the roof, false flooring, false ceiling, etc., architectural facia and

projections, miscellaneous stair details &architectural details like, coping, flashing, khurras, water proofing, fillet, roof decking, wall cladding, surface drains, rain water down comers, sanitary, plumbing, etc.

i) Design criteria and design calculations including dynamic analysis and drawings for all foundations subjected to dynamic loads like foundation for TG, BFP, Mills, Fans (PA, FD, ID& Seal Air), Crusher etc.

j) Write-up on various statutory requirements and their compliance for various buildings, facilities, structures and systems, etc.

k) As Built final Architectural drgs andAs Built- Final Shop drawings/fabrication drawings of all structural steel works(only for reference) on CDs and design calculations for important joints/connections

l) Construction and erection procedure for all major structures such as Main Plant building including Control tower, Mill and Bunker building including coal bunkers, Transfer Points, Conveyor Galleries, Boiler/ ESP structures, Chimney,Auxiliary Cooling Towers, Switchyard Structures, ~~Ash Slurry PH, Ash Water PH~~, TG foundation and other machine foundations, Clarifiers, etc. covered under the Bidder's scope.

m) In case of piling, scheme for initial pile load tests in vertical, lateral and uplift modes along with supporting design calculations, scheme of routine load test of piles, High Strain Dynamic Load Test, Pile Integrity Tests and methodology for installation of working piles.

n) In case of piling, the design of piles in terms of type, rated capacity, length, diameter and termination criteria to locate the founding level.

o) Marking scheme identifying the equipment lay-down areas, with distinctive colour scheme.

p) Material test certificates.

q) Design criteria (for approval) and drawings(for information only) for Boiler/ESP supporting structures.

r) As built drawings with quantities of various items of work system wise, building wise, structure wise, etc. duly certified by Site after execution of work for information/record.

s) Details of corrosion protection measures for all structures.

t) One complete set of applicable standards, references, specifications, code of practice along with soft copy (wherever required with minimum 2 years license fee) to the Engineer for use at site.

u) Wherever applicable, scheme for dewatering, shoring, strutting/sheet piling.

v) All other design details/drawings or any other submission as indicated elsewhere in this specification and as required by the Employer.

Commencement of fabrication and erection and construction shall be done after approval of the relevant documents and drawings. All drawings shall be of standard sizes (Metric System) and shall be made on AutoCAD. All documents shall be made using MS office. Bidder shall submit all documents and drawings as per the followings:

Drawings:	-	Soft copy via C-folder for all drawings.
	-	After approval of drawings 6 Hard copies of each construction drawing shall be submitted to Owners site office
As Built Drawings:	-	In CD (Compact disc).
Design/Document:	-	Soft copy via e-mail/ C-folder and two set of hardcopies.

In general 3D modeling and structural frame analysis and design for the plant structures shall be submitted by the bidder for Employer's review and approval. Soft copy of 3D modeling (including input and output files shall be submitted

All construction drawings shall include total quantity of concrete (grade wise), reinforcement (diameter wise) and structural steel (section wise).

4.00.00 GENERAL LAYOUT PLAN

4.01.00 The preliminary layout plan proposed for the project is shown in the drawing no. 9585-999-POC-F-001 titled "General layout plan". It shall form the basis for further elaboration by the Bidder for the plant facilities, which are in his scope.

Bidder shall prepare the detailed layout of the plant facilities which are in his scope and shall submit the same for Owner's approval.

While preparing the detailed layout, planning his facilities and deciding upon the transportation and erection strategy he shall ensure the following aspects.

a) All Statutory requirements including safe distances between various facilities as per applicable rules/acts/laws including local bye-laws are met.

b) Face of the buildings and facilities are located in such a way so as to have an offset of minimum 20m with respect to centre line of double lane road and 15metre with respect to centre line of single lane road.

c) The entire construction activity shall take into account the commissioning of the units in phases matching with the phased commissioning of the plant.

d) The interface requirements with the plant construction/erection activities of other contracting agencies engaged by Owner. These agencies engaged will be working parallely with the Bidder within the plant premises.

e) The area for construction/erection facilities like lay-down, pre-assembly, offices and stores have been earmarked on the General Layout Plan.

f) No permanent facility shall be located within the safety zone limit around the fuel Oil storage tanks, Hydrogen plant complex, etc., except those permitted by Owner.

g) Transportation of all equipment and materials shall be by road as envisaged. Any other mode envisaged by the bidder may be proposed. However the same may be adopted subject to approval of the Employer.

h) All the buildings and facilities shall be approachable by fire tenders.

4.02.00 Technical Specifications for Watch Tower

Watch Towers shall be RCC construction with all-weather enclosure at 6M height. Watch Towers shall be provided at 600 m interval along the Boundary as well as at corner turning points of the plant boundary. Watch Towers shall be provided with caged MS ladders.

4.02.01 Construction Stores

2 Nos. of Construction Stores with 1050 Sq.M. floor area of each store shall be constructed. The stores are pre-engineered buildings and design shall be as per the latest industrial practices. These stores shall be used by the contractor for the storage of material in construction phase, and after completion of work shall be handed over to owner in good condition for use by the owner in O &M stage.

4.02.02 **Steel Storage Yard**

Steel Storage Yard of 10,000 SQ.M. shall be provided with heavy duty paving as per details given in Clause No. 5.26.00. Fencing around the Steel storage yard shall also be provided as per details given in Clause No. 5.07.15.

4.03.00 **Site Levelling And Slope Protection Work**

4.03.01 Complete levelling of entire plant area and township area including the area earmarked for administration building, ash based units, ash silos, railyard and associated facilities shall be done by the Bidder.

Bidder shall carry out the topographical survey before he commences detailed design and site leveling. This survey shall cover the entire plant area ~~and township area including the areas earmarked for administration building, ash based units, ash silos, railyard, raw water pumphouse& associated facilities, reservoir and the diversion drains~~ in Bidder's scope of work. Based on field observations the contractor shall prepare and submit for Owners review the survey maps of the surveyed sited on suitable scale, indicating grid lines, contour lines and demarcating all permanent features like roads, railways, water-ways, buildings, power lines, natural streams, trees etc. For each area two sets of survey maps shall be prepared and submitted, one showing the spot levels and contours with grid lines and the other showing the grid lines, contours and permanent features.

Established methods of surveying like triangulation, traversing, fly leveling etc. shall be adopted for the survey work. Spot levels shall be taken at 25 metres interval and at closer intervals where pits, undulations etc. are met with. These levels shall be taken in two orthogonal directions. Contours shall be plotted at 0.5m interval.

It is proposed that for the purposes of site leveling the entire plant and associated areas will be divided into various blocks as defined in the drawing no. 9585-001-POC-A-001 titled, "Site Levelling Works ". Each block shall be finished to the formation level as specified in drawing. Bidder shall deploy adequate number of experienced site leveling contracting agency(s) with requisite earth moving and compacting equipment to complete the work as per schedule.

Since the construction of roads and drains for the entire plant is included in the scope of Bidder, it shall be the responsibility of the Bidder to ensure that these facilities are also constructed along with site leveling works. Bidder shall ensure that road access and drainage facilities for each block is available when site leveling in that block is completed. Unless otherwise instructed by the Engineers, all roads and drains within a block shall be constructed by the bidder within a month from the date of completion of site leveling of that block.

The specified formation level(s) shall be achieved either by excavation where the existing ground levels are higher than the specified formation level or by raising by controlled filling with borrowed earth where the existing ground levels are lower than the specified level.

The excavation shall be in all types of soils or rock or a mixture of these. Bidder should assess and satisfy himself about the actual nature of soil present at site, before submitting his bid.

In some areas excavation of ash is also involved. The excavated Ash shall be used for filling for site levelling works. Areas for Ash filling shall be identified in consultation with owner and area shall be finalised after written permission of the Engineer. Earth cover needs to be ensured over ash filling.

	All materials arising out of site clearance and excavation shall be the property of owner. They shall be dealt with in the manner specified by the Engineer. Earth / boulders / rock etc. excavated and useful portion (serviceable materials) of trees cut shall be stacked at suitable places within Owner's acquired land for the plant including the reservoir and the ash disposal area in a manner as directed by the engineer. Woods, branches, trunks of trees shall be termed as serviceable material. Other materials like twigs, leaves, roots, vegetable and organic matters etc. shall be termed as unserviceable material and shall be sorted out from the serviceable materials before disposal. They shall be cleared from the area and disposed off at places within Owner's acquired land for the plant including the ash disposal area in a manner as directed by the engineer. If the excavated material is suitable and accepted by the Engineer as fill material, the same can be used for filling in other areas where raising by filling is required. Otherwise the same shall be taken and stacked at places(s) within the plant boundary as directed by the Engineer. Filling with rock shall be done only after the written permission of the Engineer in the following manner: - Filling with rock shall be done only in areas identified for laydown and preassembly and ash based units. - Maximum size of rock used for filling should not be more than 150mm in all direction. - Original ground after removal of all organic and vegetable matters shall be consolidated by rolling as directed by the engineer subject to a minimum of six passes of 8-10 tonnes roller. - Excavated rock shall be laid (on original ground or after filling 300 mm thick layers of soil as specified), in layers not exceeding 1000 mm and rolled with with vibratory roller (10-15 tonnes static weight) with minimum six passes. - Over the compacted layer of rock, soil shall be filled in horizontal layers not exceeding 300mm in compacted thickness. The soil shall be compacted as specified elsewhere. - It shall be ensured that the top soil layer is in minimum 3 layers of 300 mm each. To achieve this the thickness and number of rockfill layers below can be suitably adjusted. Contour map and spot levels of the area based on the preliminary survey carried out by Owner is enclosed for the purpose of guidance of Bidder. Refer tender drawing no. "9585-001-POC-A-001. However, Owner does not lake any responsibility about the accuracy of the survey details furnished and any variation of the said data shall not constitute a valid reason for changing the terms and conditions of the contract. Bidder is requested to carry out his independent assessment of the existing ground levels before furnishing his. bid Detailed survey shall be carried out by Bidder after award of work and all findings as stated earlier shall be submitted for Owner's review.
4.03.02	All existing drains/channels in the plant and other areas associated with the plant except those proposed to be constructed by the Owner shall be suitably diverted by the Bidder before taking up any construction. These diversions shall be so designed as to ensure effective disposal of water without any accumulation or flooding within the limits of overall land acquisition line and in adjoining areas.

4.03.03	Before commencement of cutting/filling, all organic and vegetable matters like grass. Plants shrubs bushes, weeds, trees (with girth less than 30 cm measured at height of 1m above ground level) etc. in the areas to be filled, shall be completely removed along with their roots and disposed off. It shall also be ensured that the area to be filled is clear of any water, slush etc. Original ground shall be compacted by rolling as directed by the Engineer subject to a minimum of six passes of 8 to 10 tonne roller The earth shall then be spread in horizontal layers not exceeding 300 mm in compacted thickness. Each layer shall be watered and compacted with proper moisture content and with such equipment as may by required to obtain a compaction of 95% or more of Standard Proctor's maximum dry density. The moisture content of the fill material shall be controlled to obtain near optimum moisture content during compaction. The fill material shall be tested for determining optimum moisture content and maximum dry density by Standard Proctor Test as per IS : 2720 (Part-VII). The fill material shall also be tested for determining moisture content before compaction as per IS:2720 (Part-II) For each of the above tests, one sample for every 10,000 cubic metre of fill material shall be tested. Additional samples shall be tested, whenever there is a change in the source or type of fill material. The compacted soil shall be tested for its dry density as per IS2720 (Part-XXIX) or Part-XXVIII). Samples shall be taken at the rate of one sample for every 10,000 sq.m. area for each compacted layer. In addition random checks shall be carried out in compacted soils by means of Proctor needle penetration. Bidder shall submit to the Engineer, the test results immediately after completion of the tests. A sample shall be deemed to have passed the test when the in-situ dry density is equal to or more than the specified percentage of maximum dry density. If a sample taken from a layer fails to pass the test, the layer shall be further compacted till two samples taken and tested from this layer pass without any negative deviation. Only after this. spreading of further layers shall be taken up.
4.03.04	Before start of filling, the Bidder shall submit to the Owner his proposal for the methodology to be adopted for compaction for each type of fill material. The Bidder shall also carry out compaction trials to establish the proposed methodology. The Bidder shall start the compaction work only after approval of the methodology by the Owner
4.03.05	The surface of the cut/filled up areas after reaching final level shall be dressed to the required levels and slopes. The difference in levels shall not be more than +/- 10cm locally.
4.03.06	The borrow areas outside the overall plant boundary limits for obtaining suitable fill material which is required over and above the earth available after cutting high grounds within the plant area, for site levelling shall be arranged by the Bidder himself and all expenses in respect of royalties, taxes, duties, etc. for borrow areas/fill material shall be borne by him. He shall also obtain and submit to the Owner the necessary clearances/permission from the concerned authorities for the borrow areas/fill material.
4.03.07	Material suitable for filling shall be loaded and transported to the filling site by the Bidder. Any coarse grained or fine grained low plastic soil, free from shingle, salts, organic matter, sod or any other foreign substances, may be used for filling. The Bidder shall test the fill material to establish its suitability and submit its results to the Owner. Fill material shall be approved by the Owner. The following types of materials shall not be used for filling:

a) Material from swamps, marshes and bogs.

b) Expansive clays

c) Peat, logs, stumps, sod and perishable materials.

d) Materials susceptible to combustion

e) Any material or industrial and domestic produce which will adversely affect other materials in the work.

f) Materials from prohibited areas

4.03.08 Bidder shall include in his offer any extra filling that may be required on account of subsidence of the original ground due to overburden of filling above and/or compaction works for site levelling.

4.03.09 After levelling, the contractor shall establish concrete pillars at the intersection points of the grid lines for future reference. These pillars shall project at least 450 mm above the formation level and shall be labelled permanently with their respective coordinates and reduced levels.

4.03.10 Fillingupto the specified formation level shall extend at least 2.0m beyond the outside face of boundary wall/fence. Thereafter, it shall be finished at a suitable slope (not steeper than 1 Vertical:2 Horizontal) and provided with good quality dry stone pitching minimum 300mm thick for slope upto level difference of 3m. If the level difference is more than 3m, the stone pitching shall be provided with RCC bands of size 300mmx300mm at minimum spacing of 3m horizontal and 6m vertical spacing and with suitable benching.

4.03.11 For site levelling of railway siding area (as marked in site levelling drawing) shall also comply to railway standards and RDSO guidelines in addition to the above clauses.

5.00.00 SALIENT FEATURES & DESIGN CONCEPT

This section of specification covers salient features and design concepts of Architectural, Civil & Structural works pertaining toMain Plant Buildings, Chimney, Cooling Towers, ACW System & Make-Up Water System, Water &Effluent Treatment Plant And CPU Civil Works, FDPS System, Balance of Plant Buildings, Coal Handling & Ash Handling Systems, Switchyard Structures,Facilities For Railway Siding, Fuel Oil Handling System, Office Buildings, Roads and Drainage . FGD system.

5.00.01 Architectural concepts & design

a) Bidder shall engage a specialized architect consultants with experience in different design aspects like architecture, interior design & landscape design. The consultant shall be involved in the overall Architectural design and Character of the buildings & shall be available for discussion & meetings whenever required by the owner. However detailing work of the individual buildings may be done by In-house architects having adequate experience. The consultant shall evolve the design based on employer's guidelines and shall present it in the form of Presentation Drawings, Detail Drawings, Perspective View& 3D Model/ Walk through. All drawing and document shall be duly stamped by the Registered Architect. Perspective / Panoramic Views of Main Power House, Admin, Service, Canteen, Auditorium, Gate Complex, IT building & Time Office shall be submitted in Hard Copy in Laminated A-1 Size (Two Numbers). A Panoramic Bird's Eye View of Overall plant shall be submitted in laminated A-1 Size hardcopy (Two Numbers) A.ll drawing and document shall be duly stamped by the Registered Architect.

Drawings, Detail Drawings, Perspective View &Panormic Bird's Eye View. Perspective / Panoramic Views of Main Power House, Admin, Service, Canteen, Auditorium, Gate Complex & Time Office shall be submitted in Hard Copy in Laminated A-1 Size (Two Numbers). A Panoramic Bird's Eye View of Overall plant shall be submitted in laminated A-1 Size hardcopy (Two Numbers) A.ll drawing and document shall be duly stamped by the Registered Architect.

b) Power Plant Buildings shall be architecturally treated, based on functional requirements, in such a way that they retain the desired scale, and present a pleasing composition of mass and void. The overall impact of the buildings shall be one of aesthetically unified architectural treatment having a comprehendible scale, blending colour scheme with the surroundings.

c) All buildings and structures shall be architecturally treated in such a way so as to be in complete harmony with the main plant building, surrounding structures and environment. Due considerations shall be given to orientation, landscape design, and interior design. All finishes for floors, walls, ceiling, structural elements, partitions for offices and industrial areas shall be suitable for their aesthetics, durability and functional requirements and shall include the latest building material & technology. Consideration shall be given for achieving standardization & fast track construction.

d) Overall colour scheme of the Main plant building and other buildings shall be designed judiciously and in a comprehensive manner taking into a account the mass and void of buildings, its facade, equipment, exposed structural elements, piping, trestles, bus ducts, and other service elements.

e) For adequate light and ventilation, National Building Code recommendations shall be followed. All buildings having height more than 4.0 m shall have glazed ventilators.

f) Architectural design of Main Power House Building, Administration Building, Service Building, Workshop, O&M Store, ESP control Building & Switchyard control building shall be suitable for installation of Solar Photovoltaic Panels on roof tops for Renewable Energy Purpose.

g) All the buildings shall be architecturally designed to meet the National Building Code requirement & Fire Safety Regulations &incorporating sustainable building design features like energy efficiency, Solid waste management, water conservation and recycling, use of local material etc.

h) During design stage, Technical specification as prepared shall govern the finishes.Service building, Administration building, Canteen building, &Auditoriumshall be designed as GRIHA (Green Rating for Integrated Habitat Assessment) compliant Green building with a minimum Three (3) star rating. Bidder shall perform all services related toGRIHA certification including preliminary assessment, GRIHA facilitation, simulation& analysis leading to obtaining the final certification by GRIHA. For information aboutGRIHA, bidder is requested to visit the web site www.grihaindia.org. Bidder shall obtain and submit final certificate from GRIHA to the Owner.

IT

Bidder shall perform all services related to GRIHA certification including payment of registration fees for above buildings with GRIHA, procurement, supply and installation of energy source as per GRIHA requirement, GRIHA documentation, energy simulation and daylight analysis for obtaining the final certification by GRIHA.

i) All public buildings shall be designed incorporating the provision of barrier free environment for physically disabled persons.

j) All the buildings and site development including landscaping shall be designed to take care of Rain water harvesting & Ground water recharging. Development of rain water harvesting scheme for the project and obtaining approval of the scheme from Central Ground Water Board is in Bidder's Scope.

k) For Control Rooms of MPH/ ESP Control Buildings, Dry Wall Construction Technology shall be incorporated.

l) Overall emphasis shall be on developing eco-friendly architecture, merging with the nature with its own sustainable energy management systems. Ecofriendly architecture means design and constructions that are eco-friendly and helps to save the natural resources of the earth. . The above definition is only indicative and the bidder shall incorporate the above features into design and construction to achieve a sustainable, eco friendly architectural design for the whole project.

m) Landscape Development

There shall be comprehensive landscape development in entire Plant area to create a pleasant and healthy environment. The scope of work for landscape and horticulture work shall include supply and planting of trees, shrubs, hedges/edges/borders, grass lawn around different areas, buffer and peripheral plantation etc. The scope shall also include supply and installation of all landscape furniture i.e. Park-Benches, & Gazebos, Landscape fountain & water bodies, Landscape Pavers/ Tiles etc& all associated electrical works/ items, Mechanical works/items and civil works and all other work required for completion of Landscape development. The landscape design and drawing shall be developed by competent and signed byLandscape Architect. The landscape shall use the suitable plants and trees preferably local trees, plants, and shrubs. There shall be provision of pathways in and around the landscaped area. Around the pathways and roads, trees shall be planted. There shall be provision of drip/sprinkler irrigation system for irrigation of landscaped area. There shall be intense landscape with four water body development one each near Main gate complex, Administration building, Service building and Canteen building. Minimum size of water bodies shall be as given below:

Drip/sprinkler/pop up irrigation system shall be provided and installed by the bidder for irrigation of entire landscape area and all plantations.

Administration Building and Service Building – 5.5m diameter and 1.0m depth
Canteen Building and Gate Complex – 3.0m diameter and 1.0m depth

The landscape (including water body) around Administration Building, Service Building, Auditorium Building, and Canteen building shall meet the GRIHA requirement for 3 STAR rating.

n) The development of green belt is not in bidder scope. However, bidder has to plan the facilities leaving the space for peripheral green belt of average width of 100m around the main facilities of power plant. In addition to that laydown areas and other vacant land of the plant will be used by owner for the development of green belt.

5.01.00 **Main plant Buildings/ Structures shall comprise of:**

All floors indicted in subsequent pages shall be total area of building

a) Main Power House

b) Mill Bunker Building

c) Transfer Points , Conveyor Galleries & Trestles

d) Machine Foundations in Main Plant

e) Boiler Structure

f) Compressor House

g) ESP Structure

h) ESP Control Building

i) All Equipment Foundations & Pipe Cable Trenches/ and Pedestals below finished ground level.

j) Pipe & Cable Gallery

k) Service Building

The Main Power house, Bunker building, transfer points, conveyor galleries and trestles, boiler supporting structure, ESP supporting structures including inlet and exhaust duct support structures, Pipe cable Galleries & trestles shall have structural steel framed super structure.

All other buildings may have either RCC or structural steel framework.

Brief description of the above mentioned Main Plant Building is furnished herein:-

a) Main Power House

(i) Salient Features:

shall be of structural steel framed structure and

Main Power House ~~shall~~ consist of the Turbine bay, adjacent Deaerator Bay, electrical bay & Common Control room Building (CCR Building) (as stipulated elsewhere in this specification). The Turbo – Generator (TG) foundation, MDBFP & TDBFP foundations andshall be located inside the power house and their foundation system shall be as per design concept of machine foundation. All other equipment foundations (including Heaters & Deaerators) shall be supported on RCC floors with structural steel beams. The RCC floors shall comprise RCC slab over profiled metal deck sheets (to be used as permanent shuttering but not to be considered for design of RCC slab as composite slab). Shear anchor studs shall be provided through metal deck at regular interval on all top flange / flange plate of structural beams. However, steel gratings, chequered plate flooring as well as precast RCC covers shall be provided as per the functional requirements. All RCC pits & trenches below ground floor slab (including CEP pit) shall be covered with minimum 40 mm thick MS grating supported on structural steel beams. The RCC pits shall also be provided with a sump at the corner for dewatering with submersible pumps. Staircases & ladders shall be provided for access to these pits. EOT cranes shall be placed in the Turbine Bay with the Gantry Girders(supporting Crane Wheel Loads) supported on structural steel brackets on A & B row columns). Walkway with chequered plate shall be provided at crane girder level at both 'A' row & 'B' row side with caged ladder access from the operating floor.but

All columns ~~& beams~~ of Main Power House shall be of structural steel ~~girder (open web or solid web)~~ with base plate level of columns 1.20m below ground floor slab level in general except for other pit areas where structural steel column shall be extended below upto a depth lower than the pit top surface such that the column base plate & stiffeners are concealed below the pit raft level. ■

■ Auxiliary columns for supporting floors in AB bay in main Power House shall be either of structural steel of concrete (Pre-cast) construction. Design, fabrication/ manufacturing of precast structural members like column & beams , handling / erection and jointing there of shall be done as per IS 15916.

The roof system in Turbine bay shall comprise a structural steel girder (open web or solid web) for the entire bay width. The roof slab shall consist of 40mm thick (min.) RCC slab supported on profiled metal deck sheet. The metal deck sheet shall be supported on structural steel purlins. The purlins shall be in turn be supported on turbine bay roof girder top chord at regular interval. Additional waterproofing shall be provided above the roof RCC slab as per details mentioned elsewhere in this specification. 1 in 100 slope shall be provided for the turbine bay roof sloping downwards towards the A-row (towards transformer yard) .

Minimum 150mm dia galvanized mild steel pipes shall be used at A-row & C-row as Rainwater Down comers. Staircases in main power house shall be of structural steel. Treads & risers of each staircase shall be 40mmthick MS grating and handrail/ hand post shall be 32mmNB circular hollow sections unless specified otherwise in architectural section of the specification. All staircases in Turbine Bay and Deaerator Bay shall be enclosed with 230thk brick masonry Wall with fireproof doors at all floor landing levels. The parapet wall shall be of minimum 1m height and shall be provided all the around roof of main plant building.

All edges of openings shall have edge protection angles (minimum ISA 75x75x6) and handrails with hand posts (Hand post spacing 1.50m maximum)(Hand post spacing 1.00m maximum).

ii. Design Concept:

Main Power House shall be designed as moment resisting sway frame in the transverse direction and braced in the longitudinal direction. However, due to functional requirement, vertical bracings to the column in CCR Buildingnot to be provided at (& above) the operating floor level and CCR Building frames shall be designed as moment resisting frames in both transverse and longitudinal directions.

All beam column moment connections shall be designed for adequate ductility. The building shall have connectivity with walkways from Boiler & Service Building through sliding bearing only. The connectivity with cable gallery shall be as specified in Pipe &cable gallery section of this chapter. Floor level acceleration spectra shall be generated during seismic analysis for design of pipe supports / equipments located at the elevated floors. Adequate number of thermal expansion gap (minimum 2.00m) between adjacent structural frames at expansion joint and minimum 50mm between RCC slabs at expansion joint) shall be provided between the units and Common Control Building.

In the RCC floor/ roof slabs, the spacing of shear anchor studs on structural beams shall be minimum of the spacing required for i) the restrainment of compression flanges of beams and ii) transfer of the horizontal shear at floor/roof to the supporting beams.

The roof girder in Turbine Bay shall be provided with a camber to take care of deflection due to dead weight.

The Main columns in A, B &C rows of Main Power House Building shall be built-up I sections. Rolled sections/ I sections with additional flange plates shall not be acceptable for main columns & auxiliary columns. The roof truss to column connection shall be bolted connection using high strength bolts (grade 8.8/ IS 1367). The roof truss of Turbine Hall shall be adequately braced in plan using Tie level and rafter level bracings. The longitudinal bracing shall comprise a pair of Box sectionconnected to the column flanges and detailing shall be adequate to restrain the entire column cross- section. Minimum gusset plate thickness for bracings shall be 12mm.

The base plates of Main Columns in A, B, & C rows shall be grillage type of minimum depth 800mm and comprising bottom base plate, top cap plate & interconnecting vertical stiffeners.

The CCR Building structure shall have large span roof girders for the roof structure of main Control room such that no internal column within the control room floor exist. Which interfere with equipment layout

For all other design methodology, refer to Design Criteria specified elsewhere in this specification.

Architectural Features

This building shall be of Structural Steel Framed structure and shall be completely covered with external cladding and RCC roof.The external vertical face(herein stated as 'A' row) of Main Power House facing (& adjacent to) the transformer yard and also the two gable ends shall be completely covered with vertical cladding comprising 3.0m high brick wall (on Ground floor slab) and single skin profiled vertical metal sheet for the remaining height

except for the vertical segment between operating floor & Gantry girder bracket level where double skin vertical metal sheet shall be provided. In front of the Power Transformers, RCC fire barrier wall shall be provided as per functional requirement in lieu of brick wall at A-row.The above mentioned RCC wall shall be attached with single skin metal sheet on external face. The 'A' row & Gable End columns projecting inside the turbine hall shall be concealed with single skin profiled metal deck sheet from operating floor level to crane girder bracket top level

The external vertical face (herein stated as 'C' row) facing (& adjacent to) the Boiler area shall be completely covered upto the Deaerator floor level with vertical cladding comprising 3.0m high brick wall on Ground floor followed by either single skin metal sheeting with runners or brick wall sand witched with single skin metal sheeting on external face(for all floors requiring 4 hrs of fire rating eg Cable Spreader room, Ventillation/ Air Washer Room & AHU Rooms)

The internal vertical interface plane between Turbine bay & Deaerator bay (herein stated as 'B' row shall have brick masonry Wall from RCC roof slab level of turbine bay (AB bay) upto specified floor level below such that Turbine bay & Part of Daerator bay below the Deaerator supporting floor level is completely covered on all sides.

Glazing for A Row, C Row& Gable end shall be Reflective6mm thk clear toughened glass with Aluminium frame. Hermetically sealed double glazing shall be provided between A/C areas & non-A/C areas. Light Weight Aerated Concrete Panel with Single Skin Metal Panel cladding shall be provided in exterior of UPS Battery room area and Control Equipment Room area. All internal side of Aerated concrete panel and columns in air-conditioned areas in MPH shall be encased with Aluminium Composite panel cladding

Inside the main power house building, brick masonry wall (and fire proof doors) shall be provided for switchgear rooms, cable spreader rooms, MCC rooms, AHU rooms, Air Washer room & Oil rooms and all other rooms where fire protection is envisaged.

Cut-outs and opening shall be provided in floors and walls as per functional requirement.

All door, windows in air conditioned area and all windows glazing shall be provided with Aluminium frame work Steel door and Fire Proof doors shall be provided as per requirements.

All peripheral edges of floor cutouts / openings at TG Floor level and covered with grating / chequered plates, Expansion joints along TG deck, structural expansion joints shall be covered with 2 mm thick stainless steel plate of Grade SS316

Stairs in BC Bay and on A-Row shall be provided as per functional requirement and as per National Building Code and factories Act.

All stairsin BC Bay lift lobby Area shall bein RCC. Stainless steel railing shall be provided at TG Floor level for all cut-outs/ openings, walkway at ~~24.0m~~, cut-outs at lower level that are visible from TG Floor level and stairs near lift lobby.M.S. railing shall be provided for all other locations. ~~Flooring interface with Floor cut-outs and R.C.C Slab at operating Floor level shall be finished with 3mm thick Stainless Steel plate of grade SS 316~~.

separating Air -conditioned and non-Air-conditioned areas shall be of 24mm thick Hermetically sealed double glass consisting of Fire resistant glass of min 11mm thick clear, toughened, inter layered 120 minute fire rated for both integrity and radiation control and 6mm thick tinted glass with 7mm gap and with suitable fire rated frame of 1.3mm thick galvanized steel sheet.

The partition shall be up to false ceiling level and wall above up to 24.0M/25M shall be finished with Aluminum Composite panels cladding.

For each unit minimum one no. Gent's toilet with adequate facilities including Drinking water space and Janitor's space shall be provided at each level of Power house Building, in addition one no Ladies toilet shall be provided in each unit at 0.00M and Mezzanine floor level and CCR Level. A separate ladies and Gent's toilet and pantry shall be provided for CCR approachable from CCR / CER.

B Row portion in TG Hall ~~fronting Control Room&CERand glazed partitions in CER/ CCRshall be of Fire resistant of min 11mm thick clear, toughened, interlayered 120 minute fire rated for both integrity & radiation control partitions up to false ceiling level and wall above up to 24.0 M, finished with Aluminuim Composite panels cladding~~.

Control room/ Control Equipment Room, False Ceiling shall have Cat Walk Way above for service/ maintenance.

Main power house building shall be provided with passenger lift in BC way as specified in

subsection A-05 of PART-B of technical specification.

Adequate partitioning as per functional requirement above false ceiling in control Room& CER shall be provided for Inert Gas zoning.

Internal steel columns in Air Conditioned Area of Main Power House Building shall be encased with Aluminium Composite Panelling up to false ceiling.

Functionally the very heart of Power House Building is its Control Room. Special attention shall be given for conceptualisation of interior design of the Control Room.

Metal Panel Cladding shall be composed of Different Colour shades to match with the surroundings. External finish of Masonry wall shall be premium acrylic smooth exterior paint with silicon additives finish.

Mill and Bunker building

Salient Features

The mill bunker building shall house coal mills, feeders, Cylindrical Coal Bunker & Conical Hopper, Tripper Conveyor & its drive and monorails. All columns, main beams and secondary beams shall be made of structural steel. The RCC floor slabs (supporting the Feeder and Tripper Conveyors) shall comprise RCC slab supported on profiled metal deck sheet (to be used as permanent shuttering) not to be considered for design of RCC slab as composite slab) and shear anchor studs welded to the top flange plate of secondary & main structural steel beams, (which supports the RCC slab & metal deck sheet).

Bidder shall integrate the Mill & Bunker Building with boiler supporting structure.

Access platforms shall be provided at minimum one (1) level above bunker supporting level for inspection and testing of bunker and hopper connections. Minimum (1) Nos. of man hole/ access window shall be provided for maintenance of silo.

The bottom level of base plates of columns shall be 1.20 m below the finished floor level of ground floor of Main Power House. The columns of Mill-Bunker building shall consist of built up structural steel I-sections. Rolled sections with additional cover plates on column flange shall not be acceptable for column sections.

The cylindrical coal bunker and conical hopper shall be made of structural steel. The inside surface of hopper shall be lined with stainless steel plates the details of which are mentioned hereafter in this specification.

Structural steel brackets with PTFE bearings shall be provided at the end columns to support the external gallery of the Tripper Conveyor

The Mill-Bunker building roof shall be provided withPre-fabricated insulated metal sandwich panels. Composition of Insulated Metal Sandwich Panels shall be as described in Clause 9.08.00, Part-B (Civil) of Technical Specification. Adequate slope shall be provided for quick drainage of rain water.

The RCC floor supporting the Tripper Conveyor shall be fully covered upto the Roof level with single skin metal sheet (& structural steel runners).

Design Concept

The Mill Bunker Building shall be conceptualized as moment resisting frames in transverse direction and longitudinal direction. In the transverse direction the bracings may be provided, wherever feasible, in order to meet the deflection requirement specified elsewhere in this section. Bracing member shall be connected to column flange plate through gusset plate (minimum 12mm thick).

Minimum wall thickness of structural steel Bunker plates (cylindrical shell) shall be 12mm inclusive of 5 mm corrosion allowance. Minimum wall thickness of Hopper shall be 12mm.

~~Minimum thickness of structural steel Bunker plates shall be 12mm inclusive of 4mm corrosion allowance~~. Minimum wall thickness of Hopper shall be 8mm. Minimum thickness of stainless steel liners on the entire inner surface of hopper wall shall be 4mm conforming to ASTM A240 S304 (Type 304) with Mill finish 2B cold rolled, annealed, descaled (pickled) and

skin passed . To ensure smooth flow of coal, the hopper surface shall be provided with minimum angle of 73° with the horizontal plane.

The top of the cylindrical bunker shall bear no load/ reaction from the tripper floor and accordingly neoprene bellow strap shall be provided at the interface between the two structures to allow free deflection of the tripper floor. Neoprene bellow strap shall be provided all-round the bunker to effectively seal the gap between top of bunker and sealing plate below bunker.

For all other design methodology, refer to Design Criteria specified hereafter in this specification.

A. Architectural Features

The Mill & Bunker Building shall be a structural steel framed structure having RCC floors and prefabricated insulated metal sandwiched panel sloped roof. The tripper floor side cladding shall be Single skin Metal cladding with steel louvered windows and fixed windows with poly carbonate sheet glazing. Area of windows shall be minimum 10 % of floor area. Rainwater down comer shall be of galvanized MS pipes and shall be located at every column location.

b) Transfer Points and Conveyor Galleries in Main Plant Area

Transfer Points

The transfer points shall be framed structure of structural steel work having RCC floors (supported on structural steel beams) and prefabricated insulated metal sandwiched sheet sloped roof. The RCC floor slabs shall comprise RCC slab supported on profiled metal deck sheet (to be used as permanent shuttering not to be considered for deign of RCC slab as composite slab) and Shear anchor studs shall be provided with stud welding through metal deck at regular interval on all top flange / flange plate of structural beams which support the RCC slab. The side cladding shall be Single skin Metal cladding (from lowest working floor level till roof top) with steel louvered windows and fixed windows with poly carbonate sheet glazing. Area of windows shall be minimum 10 % of floor area. However the lower portion of side cladding for a minimum height of 0.9 m above the finished floor level shall be one brick thick wall plastered on both sides. In some areas like MCC floors etc., one brick thick wall cladding shall be provided. Brick wall cladding shall be supported on encased wall beams and suitably anchored to adjoining columns and beams. ~~Contractor shall have option to use Tubular steel sections for vertical & horizontal bracings~~. Horizontal bracings at all platforms levels shall be designed as beam carrying axial force and bending moment to take care of loads from platforms for maintenance and Gravity Take-up.

Brackets and beams for supporting the Conveyor gallery portal shall be provided at required elevation on columns of Transfer Point.

Grade slab shall be provided for all transfer point houses.

Steel doors and sliding steel doors of required sizes as per system requirement for personnel access and handling of equipment respectively shall be provided.

The roof of Transfer points shall be provided with pre-fabricated insulated metal sandwich panels. Pre-Fabricated Insulated Metal Sandwich Panel for Roofing shall be laid to specified slope. Composition of Insulated Metal Sandwich Panels shall be as described in clause 9.08.00, Part-B (Civil) of Technical Specification. Adequate slope shall be provided for quick drainage of rain water.

For TP's in Main Plant Area, each down comer shall lead the water / coal slurry into the RCC pit (of 2 Cu.M capacity) to allow settling of coal. The water from the pit shall overflow into R.C.C drain (RCC drains with steel gratings provided around the TP), which will lead the discharge finally into plant effluent drain routed alongside the nearby road.

All stairs of over ground portion of transfer houses shall be of steel (minimum 1000 mm wide)and maximum rise should not be more than 180 mm and minimum tread width 250 mm.

Stringers shall be of rolled steel channel(minimum ISMC 250)and tread shall be of electro-forged steel gratings. Stairs shall be provided with 32 mm dia nominal bore medium duty M. S. pipe hand rail.

Handrails (for staircases, around openings, in walkways etc.) shall be of standard weight steel pipe of flush welded constructions, ground smooth using 32 mm nominal bore medium class pipe provided with double rail, top rail about 1.0 metre above platform level and pipe posts spaced not more than 1.5 metres apart. Angle handrail post may be provided when specifically called for in drawings approved by Engineering. Toe guard of size 100mm x 6mm shall be provided along the railing for all steel platforms/landings and RCC staircases.

Smooth uniform curves and bends shall be provided at stair returns and also where so ever required. Posts connected to curb plates shall have a neat closure at the bottom and a 6 mm thick plate neatly welded to posts for attachment to curb plate. All necessary fittings including inner dowels at splices, brackets, belts, bends, flanges and chains, where required shall be plugged and welded. A minimum radius of 3 times the pipe diameter shall be provided at all points of direction changes in the handrail.

Treads and landing shall be suitable for the prescribed loading. The maximum width of openings in gratings shall not exceed 40 mm. The minimum size of main bars shall be 25 x 6 mm and cross bar shall be 6mm. The usual span of grating will not generally exceed 1.5 meters. Stair case gratings shall be galvanized to grade 610g/m2.

Out side stairs to transfer points shall be open type. However sheeting shall be provided at the top.

Numbers and arrangement (including enclosures etc.) of stair cases shall be such as to meet the fire safety requirement as per guide lines of statutory regulatory bodies.

Last TP in main plant area shall be designed and constructed to take care of loads due to future expansion of conveyor gallery.

Conveyor Galleries and Trestles in Main Plant Area

Troughed belt conveyors in Main Plant Area shall be housed in a suitably enclosed gallery of structural steel. The overhead gallery shall consist of two vertical latticed girders having rigid jointed portal frame at both ends. Cross beams at floor level supporting conveyor stringer beams shall be made of single rolled steel beam or single channel section (ISMB or ISMC) or plate girder. Horizontal bracings are to be provided at top & bottom plan of the gallery (latticed girders shall be braced together in plan at the top and bottom). Common end portal frame shall not be used for adjacent conveyor spans. Roof truss shall be provided at upper node points of latticed girders to form an enclosure. Conveyor gallery shall have permanently colour coated steel sheet covers on roof and both sides. However in roof, a panel of minimum 1.5 m x 1.5 m area at about 6.0 m center shall be provided with translucent sheets of polycarbonate material for natural lighting. A continuous slit opening of 500 mm shall be provided on both sides just below the roof sheeting. Adequate provision of windows shall be kept on both sides of conveyor gallery as appended in Mechanical Section (Belt conveyor system). Windows shall be provided with wire mesh as specified elsewhere in this specification.

The maximum span of conveyor gallery shall be limited to 25 meters unless higher span is required due to site conditions, which shall be subject to approval of the Engineer. The gallery should as far as possible be erected as a box section keeping all the vertical and horizontal bracing tied in proper position. The gallery should be checked for all erection stresses that are likely to develop during handling and erection and if required, temporary strengthening of gallery members during erection shall be made. Contractor can also use tubular steel sections for roof truss of conveyor galleries only. The tubular steel section shall be of circular/rectangular/square shape. The circular steel tube shall conform to IS 1161 and rectangular/square steel sections shall conform to IS 4923. The steel structures using tubular sections shall be designed and fabricated as per IS 806 – “Code of Practice for use of steel tubes in general building construction.” and EN 1993-1-8:2005.

Minimum grade of steel & thickness of Tubular/Hollow sections shall be Yst 240 MPa & 4.0mm respectively.

For double stream conveyor gallery, two side and one central walkway of minimum width 800 mm and 1100 mm respectively shall be provided. The minimum width of two side walkways for single stream conveyor gallery shall be 800 mm and 1100 mm respectively. Both sides of central and side walkways shall be provided with pipe handrails all along the conveyor gallery. Hand railing should not be supported on conveyor supporting stringers. The walkways shall be of chequered plate construction with anti - skid arrangement. The anti - skid arrangement will consist of welding of 10 mm square steel bars at a maximum spacing of 500 mm along the length of the gallery. Where the slope of walkway is more than 10 degrees, chequered plate steps with nosing and toe guard shall be provided. Seal plates under the conveyor galleries shall be provided in such a way that complete gallery bottom shall form a leak proof floor. The floor of conveyor gallery all along the gallery length, shall be provided with minimum 12 gauge thick seal plates and other drainage arrangements as specified elsewhere.

Conveyor gallery shall have permanently colour coated steel sheet covers on roof and both sides. However in roof, a panel of minimum 1.5 m x 1.5 m area at about 6.0 m center shall be provided with translucent sheets of polycarbonate material for natural lighting. A continuous slit opening of 500 mm shall be provided on both sides just below the roof sheeting. Adequate provision of windows shall be kept on both sides of conveyor gallery as appended in Mechanical Section (Belt conveyor system). Windows shall be provided with wire mesh as specified elsewhere in this specification.

Conveyor gallery supporting trestles located between transfer points / buildings shall be four legged type only. One end of each gallery span shall be hinged to the supporting trestle and the other end shall be slide type. Slide type support shall be with P. T. F. E. bearings to allow both rotation & longitudinal movements.

End of conveyor gallery which will be supported over transfer point, shall be so detailed that only vertical reaction is transferred from conveyor gallery and no horizontal force in longitudinal direction is transferred from conveyor gallery to transfer point structure and vice - versa.

For trestles and trestle foundations for conveyor galleries located adjacent to existing structures, over ground and underground facilities, location and details of these trestles and foundations shall have to be decided such that there is no interference both underground as well as over ground with existing structures and facilities. Trestle columns base shall be kept 1.2m below the finished floor level of ground floor of Main Power House.

d) MACHINE FOUNDATIONS IN MAIN PLANT AREA

Salient Features

The scope of work of the Bidder shall be design and construction of all Civil & Structural Works of Machine Foundations including supply of all materials, springs & viscous dampers.

Turbo- Generator (TG) foundation:

Alternative-1

The TG foundation shall comprise RCC top deck supported on steel helical springs & viscous dampers (called herein as the Vibration Isolation System – VIS) and shall be located in the Turbine bay of Main Power House. The springs-cum-viscous dampers shall be placed on a group of RCC/ Structural Steel columns. These TG columns can be interconnected to the Main Power House Building frame either rigidly or connected through PTFE bearings on corbels/ brackets of the TG Columns. The general arrangement & details of springs/ viscous dampers and supporting group of columns and beams shall be based on TG Equipment detail of the Bidder.

Alternative-2

The TG foundation shall be conventional machine foundations comprising of RCC top deck directly supported on substructure comprising of columns and beams without any steel helical springs and viscous dampers. The columns shall be rigidly connected to the RCC deck at top and shall rest on open / pile supported foundation at bottom. The entire foundation system (including deck, columns and raft) shall be isolated from the main plant building structural system and no connection between the main plant structure and TG foundation is permitted.

Bidder has the option to choose either Alternative -1 or Alternative-2 based on his design philosophy and practice. However in case Alternative-2 is adopted by bidder, then the bidder has to furnish extended warranty of five years for satisfactory static and dynamic performance of the foundation system.

TDBFP & MDBFP foundations:

Alternative-1

TDBFP&MDBFP foundations shall consist of RCC top deck supported on steel helical springs & viscous dampers inside Main Power House. In case the top deck is located at operating floor/mezzanine floor level, the springs/ viscous dampers shall be supported on a group of structural steel columns-beam grid which shall be rigidly integrated with the Main Power House Structural frame.

Alternative-2

TDBFP&MDBFP foundations shall consist of RCC top deck directly supported on RCC/ structural beams and columns without any steel helical springs & viscous dampers inside Main Power House. The structural columns and beams supporting the TDBFP / MDBFP shall be independent of the Main Power House Structural frame and shall also have independent foundation without any connection to other nearby foundations. Further each TDBFP / MDBFP shall have independent supporting structural arrangement without any interconnection among themselves.

Bidder has the option to choose either Alternative-1 or Alternative-2 based on his design philosophy and practice. However in case Alternative-2 is adopted by bidder, then the bidder has to furnish extended warranty of five years for satisfactory static and dynamic performance of the foundation system.

BFPs in ground floor

In case the MDBFP/TDBFP foundation is envisaged to be located at ground floor of Main Power House, then these shall be designed as block foundations directly resting on soil / pile. Vertical facing of this block foundation shall be isolated from adjacent footings by providing minimum 100mm thick polystyrene board of type-1 conforming to IS:4671 with density 20 Kg/Cum sandwiched between the vertical face of block foundation and 230 thick brick wall all round.

PA/ FD/ID Fan and Coal Mill foundations:

PA/ FD/ ID Fan and Coal Mill foundations shall be RCC block foundation directly resting on virgin soil/ pile below Ground level. The vertical faces of this block foundation shall be isolated from adjacent footings by providing minimum 100mm thick polystyrene board of type-1 conforming to IS: 4671 with density 20 Kg/cum sandwiched between the vertical face of block foundation and 230 thick brick wall all round.

Design Concept:

a) For the foundations of Turbo-generator, Boiler feed pumps, Fans (ID, FD and PA), Mills, etc. detailed static and dynamic analysis shall be done.

b) The vibration isolation system (where ever applicable) supplied shall be of proven make and shall be in successful operation supporting machines like steam turbo-generators, BFPs, etc.,

c) Wherever alternative-2 is adopted by the bidder for TG or BFPs, suitable provisions to be ensured by the bidder in their General Arrangement and design to prevent transmission of vibration from these machine foundations to other nearby structures / foundations.

d) The bidder or his consultant should have adequate prior experience in design of machine foundations for the respective alternative to be adopted by the bidder and the machines should be in successful operation for at least one year prior to the date of submission of bid.

For detailed specification of steel helical springs and viscous dampers refer General Specification Chapter.

e) BOILER STRUCTURE

A. Salient Features

The Boiler supporting structure shall be structural steel framed superstructure adequately braced in vertical planes in both the orthogonal directions. The general arrangement & details of structural steel columns, beams, bracings, ceiling girders etc shall be as per the Bidders Boiler Structure design and detailed engineering scheme.

The bottom base plates of Boiler structure columns shall be 1.20m below the finished paving level in the Boiler area. The RCC pedestals supporting the column base plates shall be extended in order to provide RCC encasement to the structural steel columns up to at least 350mm above the top of the paving RCC slab.

Bidder shall integrate the boiler supporting structure with Mill & Bunker Building Structure. Boiler Roof (Penthouse)/canopy/ side cladding shall have single skin trough-ed profile permanently color coated sheets.

B. Design Concept

Boiler supporting structure shall be designed by the Bidder based on working stress method for structural steel and IS: 456 for RCC.

f) MACHINE ROOM

Floor of Machine Room shall be provided with profiled metal decking sheet. Trough shall be filled with Insulating Material (glass wool or rock wool) and thereafter finished with Minimum 50 mm thick wooden flooring, consisting of 37 mm thick hardwood planks, finished with 11mm thick laminated wooden flooring (of 'pergo' or equivalent) with plank size 193x1195mm (material class shall be 34 as per EN13329), over 2 mm expanded polystyrene foam and polythene sheet under laying.

Roof and Side enclosure of Machine Room shall be provided with Prefabricated Insulated Metal Sandwich panels. Composition of Insulated Metal Sandwich Panels shall be as described in Clause 9.08.00 of Part-B (Civil) of Technical Specification.

Doors of Machine Room shall be Double Plate Steel flush doors of thickness 45 mm with steel sheets of 18 gauge with necessary stiffeners. Space between two sheets shall be filled with mineral wool insulation. Frame of doors shall be pressed steel sheets of 16 gauge. All necessary fittings for the doors shall be provided by the Bidder. Rubber sealing, for making the Doors airtight shall also be provided.

Windows/ventilators shall be of standard extruded AnodisedAluminium Sections of minimum 2 mm thickness with 24 mm hermitically sealed double glazing consisting of two 6 mm thick toughened glass separated by 12 mm. gap.

Technical requirements of prefabricated insulated metal sandwich panels/decking sheets shall be same as given elsewhere in this specification

g) Compressor House

(i) Salient Features:

The compressor house shall be a structural steel framed superstructure with a hand operated overhead crane of required capacity. The gantry girder for the crane shall have walkway with chequered plate on both rows and cage ladder access.

The roof shall comprise minimum 40mm thk RCC slab (with additional water proofing) supported on profiled metal deck sheet and purlins. The ground floor slab shall comprise of all RCC block foundations, cable trenches and pipe trenches. The building shall be completely covered with vertical cladding and roof.

(ii) Design Concept:

The Design of Compressor House shall be based on working stress method for Structural Steel & IS 456 for RCC. The structural frame shall be moment resisting sway frame in the lateral direction and longitudinally braced in the longitudinal direction. Design shall also be based on the Design Criteria specified elsewhere in this specification.

Architectural Features

This building shall be steel framed structure with brick wall up to window sill height & Single Skin Metal Panel cladding above it. The roof system shall be as per the detail furnished in the salient features of this building

Cutouts and opening shall be provided in floors and walls as per requirements.

Metal Panel cladding shall be composed of different colour shades to match with the existing surroundings. External finish shall be of Premium Acrylic Smooth Paint with Silicone additives

The size, height, door/window/rolling shutter details and building size shall be as per the approved equipment layout plan of the bidder.

h) ESP structure:

Salient Features

The ESP structure shall be a structural steel superstructure with vertical bracings in the required vertical planes in both longitudinal and transverse directions, the details of which shall be as per the approved ESP equipment GA & details of the bidder.

The bottom of base plate for ESP structure columns shall be 300mm above the finished paving level in ESP area. The RCC pedestals supporting the column base plates shall be extended accordingly above the top of the paving RCC slab. Further, the gusset plate / base plate shall be encased in concrete up to the top of bolts.

Design Concept

Design of ESP structure shall be based on Working stress method. It shall be an axially braced structure in both orthogonal directions. The ESP supporting columns

shall be suitably strengthened about the minor axis for sliding movement of the base plate of ESP due to thermal movement.

i) ESP Control Building

(i) Salient Features

ESP Control Building shall be structural steel superstructure with RCC floors at ground floor level and upper levels. The RCC floors at upper levels shall support the Switchgears, cable galleries and Control Room. The RCC floors at upper levels shall be cast in situ RCC slabs supported on profiled metal deck sheet and structural steel beams.

The roof of the building shall comprise of minimum 40mm thick RCC slab supported on profiled metal deck sheet and structural steel beams. The rainwater down comers shall be as per specification and shall be suitably concealed.

The external Transformer Yard of the building shall comprise the transformer foundations and cable slit below ground level.

The building shall have Lift structure with lift pit below ground level and staircase at each gable end of the building.

(ii) Design Concept

The Design ESP Control Building shall be based on Working stress method for Structural Steel & IS 456 for RCC. The structural frame shall be moment resisting sway frame in the lateral direction and longitudinally braced in the longitudinal direction. Design shall also be based on the Design Criteria specified elsewhere in this specification. However, bracings in any internal axis may not be possible due to functional requirement and columns in that row shall be designed for biaxial bending

ArchitecturalFeatures:

This building shall be Double storeyed Steel Frame structure & shall be completely covered with Light Weight Autoclaved aerated concrete panels on all four sides except for the portion in front of the external Transformer Yard. Provision for glazed/ fire proof doors & windows shall be included. Minimum 345mm thk brick wall shall be provided for the external brick wall facing the adjacent transformer yard and the brick wall height shall be 600mm above the highest point of the transformer. Inside the building, AHU rooms, UAF Room& Battery rooms shall have brick masonry of one brick thickness. The internal walls of air-conditioned area shall be finished with Aluminium Composite Panel Cladding.

Entire transformer yard, which shall be adjacent to the building, shall be provided with metal fencing with gates.

The building shall accommodate cable vault, toilet, staircase, switchgear rooms, control rooms and AHU room. An auxiliary transformer yard with fencing and gate shall be provided adjoining to the building. Control room and VFD room shall be air-conditioned and shall have false ceiling. Windows& Ventilators all shall be provided with Aluminium sections. All doors, windows in air conditioned area shall be provided with hermetically sealed toughened glass glazing in Aluminium frame work Steel doors and Fire proof doors shall be provided as per requirements. Internal columns in Control Room shall be encased with Aluminium Composite Panel cladding/ Laminated Board Panelling

Minimum 2 Nos. of stairs and 2 Nos. of Toilets shall be provided as per requirement. Cut-outs and opening shall be provided in floors and walls as per requirements.

External finish shall be of Aluminum Composite Panel Cladding .

j) All Equipment Foundations & Pipe Cable Trenches/ and Pedestals below finished ground level.

k) Pipe & Cable Gallery

(i) Salient Features:

However, trestles for pipe and cable galleries shall either orf structural steel or concrete (Pre Cast) construction. Design, fabrication/ manufacturing of precast structural members like column & beams handling /erection and jointing there of shall be done as per IS 15916

The Pipe- Cable Gallery shall be Structural Steel Superstructure with Steel Truss (Lattice Girder) having a general span of 15.0m/20.0m. The steel truss shall be supported on 2 legged/ 4 legged trestles the arrangement of which shall be developed by the Bidder. The width of the Gallery shall vary depending on the functional requirement. A walkway of minimum width 600mm shall be provided along the Cable Trays supporting floor of the gallery. The walkway shall comprise 40mm thick MS grating and 1.0m high handrail made of 32NB MS pipes.

Plan bracings shall be provided at all chord levels of the cable gallery truss. Minimum gusset plate thickness shall be 8mm for all connections.

The level of the bottom chord (bottom of steel) of the gallery shall be at least 3.0m above the finished paving level in general. However, at all road crossings, the level of bottom of steel of the gallery shall be at least 8.0m from the top of road surface and 8.5 m from top of rail track. Before and after the road/rail crossings, a barrier of suitable height shall be constructed so as to prevent the approach of cranes (having height more than 8 m) etc, up to the pipe/cable racks/trestles.

The Caged structural steel ladder shall be provided at an interval of 200m for access to the Pipe-Cable Gallery Walkway.

~~The total length of pipe cable gallery shall be between 4 km & 8km approximately depending on the plant layout developed by the bidder.~~ Suitable expansion gap shall be provided in the gallery structure by providing twin two-legged trestles at the expansion gap. The expansion gap shall be provided at an interval of 100 to 120m. Expansion gap shall also be provided at location where changes in plan dimensions (gallery width) take place abruptly.

At the inter-connection of Pipe/Cable gallery with Plant buildings, Pipe/Cable gallery shall be terminated at a maximum distance of 1.50m from the building. The foundation of the Pipe/Cable Trestle shall be constructed at a distance of 4.0M from center line of the plant building. Cantilever of 2.50m shall be taken from pipe-cable gallery/ trestle structure.

The foundation for Pipe-Cable gallery trestles shall comprise RCC pedestals with footings. The footing base shall rest on virgin soil. In case virgin soil depth is high, the gap shall be filled with PCC (M10 grade). The grade of concrete for RCC footing & pedestals shall be M25. The structural trestles shall not be supported on paving RCC slab.

(ii) Design Concept:

The pipe-cable structure shall be designed as a 3-dimensional space frame for all the relevant load cases mentioned in the design criteria chapter.

The gallery being an unclad building, wind load shall be evaluated based on the projected frontal area of the structural members and cable tray depth.

The end portals shall be designed as rigid frames hinged (pinned support) at the base plate level(on top of the trestle column). Deflection of end portal due to wind

shall be evaluated at the portal column-rafter joint. The gallery vertical truss shall be designed as simply supported girders on trestles and detailing of end portals shall be done accordingly.

l) Service Building

This building shall be an RCC structure having RCC frame with RCC floors and roof slab. For the building, floor-to-floor height shall be as per architectural features. A connecting corridor with MPH building shall be provided at operating floor level. The building walls shall comprise aerated concrete blocks from ground floor to roof level. The grade of concrete for RCC frame (including foundation) shall be M25.

Architectural Features

This building shall be Five storeyed (Ground +4 stories above) and shall be provided with floor area of 4500sq.m with RCC framed structure. Autoclave Aerated Concrete Block masonry wall shall be provided for the full height of the building for both external and internal walls. Floor-to-floor height shall be minimum 4.25m. A connecting corridor with Main Power House building shall be provided at operating floor level. The floor of the connecting corridor shall have vitrified ceramic tiles, stainless steel hand rail & fixed windows. The connecting corridor shall have double skin metal cladding & insulated metal sheet sloped roof.

Hermetically sealed double glazing with toughened glass shall be provided for external glazing.

A minimum 70 mm margin for floor finish to be kept for provision of metallic raceway.

This building shall provide offices for Operation staff, Conference room for 50 persons, C & I Laboratory, Exhibition Hall, VIP Lounge etc. This will be fully air-conditioned building with adequate provision of toilets, pantry, cabins for senior executives and separate rooms forexecutives, supervisors etc. Lift structure with RCC lift pits shall be located inside the service building. Separate toilet facilities shall be provided for ladies and gents in each floor. One toilet shall be provided for physically handicapped on each floor. The building shall have provision of attached toilet with the cabin for senior executives and conference rooms. 2 no's of staircases and 2 no's of lifts with adequate capacity shall be provided. One store room shall be provided

Covered parking space for 10 nos. cars shall be provided. Covered parking shall be of RCC construction. Open parking space for 45 nos. cars & 75 nos. scooters shall be provided. Minimum 23 sq.m./car (including circulation area) and 5 sq.m./Scooter (including circulation area) shall be considered for working out parking space.

The service building shall be fully IT enabled. 300x40 mm GI Raceway with standard length 2500 mm single compartment trunking raceways made from 14 gauge (minimum) pre-galvanised sheet including fasteners, floor support, connectors, bends cross-way, earthing stud for fixing etc. complete as per requirement, drawings and instructions of EIC shall be laid under floors of service building for IT enablement. 350x350x50 mm Junction boxes of pre-galvanised sheet with cover plate for raceways shall also be provided

External finishing shall be of premium acrylic smooth exterior paint with silicone additives and Coloured Aluminium Composite panel combination.

5.02.00 Chimney

5.02.01 Salient Features

Single flue or Multi-flue chimney(s) shall be provided, catering to 3x800 MW units of the project. Chimney(s) shall be of reinforced concrete construction. There shall be one flue (liner) for each unit. The flue gas emission point shall be minimum 275 meters above the

plant grade level.

The chimney shell (windshield) shall be constructed using slip form shuttering. Internal platforms of steel structure shall be provided for enabling access to various elevations of the chimney and to provide support to the flue liners. Spacing of internal platforms shall not exceed 45.0 M. The platform beams shall be supported on concrete shell using suitable load bearing arrangement in the recesses provided for the purpose. The platform beams getting supported in the chimney shell shall have complete bearing support within the thickness of shell at that location and shall in no case be supported completely/partially on corbels/ brackets from the shell. "Through openings" in shell if provided ■ ~~for supporting platform beams, the same shall be closed with closure wall made of RCC on the external face of the shell~~. Openings in the concrete shell for flue duct entry, access door & truck entry door at ground level, air ventilation etc shall be provided. Hand railing shall be provided all around internal staircase & around the ventilation voids in the internal platform using min. 32 mm nominal bore MS pipes of medium class conforming to IS:1161 ~~and shall be galvanized as per IS:4736 and finished with suitable paint as specified elsewhere in the specification. The minimum weight for galvanizing shall be 610 gm/sq.m and shall comply with relevant IS Codes. All welding shall be done before galvanizing~~. Spacing of railing posts shall not be more than 1500 mm centre to centre with a minimum height of 1200 mm. The handrail shall have three rows of horizontal members between the railing posts including the top member. Kick plate of min. size 100x6 thick shall be provided in the hand railing.

■ to facilitate erection of platform beams shall be closed with cast-in-situ RCC closure wall on the external face of the shell. Necessary dowel bars shall be provided in the shell during construction for this purpose.

The flue duct outside the chimney shall be suitably connected to the flue liner inside the chimney through a transition duct. The transition duct shall be bottom supported and shall be profiled into a circular shape to connect to the flue liner. The flue duct shall be so designed that no load is transferred on the chimney shell due to the duct. The interface between the flue liner and the transition ducting shall be provided with non-metallic fluroelastomeric fabric expansion joint.

The expansion joint in the flue liner shall comprise of non-metallic fluoroelastomer material suitable to withstand a temperature of 300^{0}C, shall be acid ~~resisting~~ * and shall prevent dust accumulation. The space between the expansion joint material and the liner shall be packed and sealed by providing a bolster made up of light weight compressible material suitable to withstand a temperature of ~~of stainless steel wire mesh~~.

* resistant to withstand acid flue gas condensate arising out of flue gas parameters & operating conditions as specified elsewhere in the specification

300 Deg C and acid resistant to withstand acidic flue gas condensates arising out of flue gas parameters & operating conditions as specified elsewhere in the specification. The bolster shall be confined in texturized glass fabric having final covering of stainless steel wire emsh.

Chimney roof shall be of RCC slab over a grid of structural steel beams and provided with rainwater drainage system. An internal structural steel staircase supported from chimney shell with chequered plate floor panels and pipe handrails, shall be provided for full height of the chimney and an internal cage ladder for a small height, over last staircase landing to access the chimney roof through a roof access hatch.

The other components of the chimney include liner test ports (for continuous pollution monitoring), liner hatches, grade level slab of RCC with metallic hardener floor finish, a large electrically operated grill type roll-up door and personnel access metallic door at grade level, roof drain basin, rain water down comer pipe (150 mm dia galvanized pipe), connection to plant drains, louvers with bird screens for ventilation and all other openings in the wind shield, galvanized mild steel strake (if required), all finishing works, electrical power distribution boards, lighting panels, power & control cabling and wiring systems, stair and platforms lighting, socket outlet, lightning protection and grounding system, aviation obstruction lighting with photoelectric controller etc, communication system, a rack and pinion elevator and other items, though not specifically mentioned but reasonably implied and necessary to complete the job in all respects.

Aviation Warning Lights (AWL) shall be mounted on door panel of required size (openable from interior of chimney shell) fixed to openings in the chimney shell at locations and levels specified elsewhere. Suitable provision for approach to the AWL shall be provided at the platform level. AWL shall be located at about 1-1.5 metres above the top of platform to enable easy handling for maintenance.

The size of roll-up door shall be determined based on minimum requirement for ventilation and transportation & erection of flue segments.

5.02.02 **Design Concept**

Design and construction of various components and systems of the chimney shall be in accordance with relevant Indian Standard and where provisions are not covered in Indian Standard, reference shall be made to ACI, BS, CICIND and other international standards.

In case of any conflict between this document and the Indian and International Standards, the stipulations of this document shall prevail.

Imposed loading for design of all chimney components shall not be less than 5 KN/ Sq.m. An additional 25% of liner load shall be taken as impact loading for liner erection in addition to the liner load.

The min. thickness of web for plate girders shall be kept as 12 mm.

Seismic forces on the chimney system shall be determined based on site specific seismic information provided elsewhere in this document.

Wind forces on the chimney system shall be determined based on site specific wind design criteria provided elsewhere in this document.

The chimney and its components shall be designed to resist the most onerous forces resulting from all the possible combinations of the various loadings. Design of all chimney components shall be based on working stress method.

Wind Shield

The load calculation and load combinations shall be detailed in IS 4998 (Part 1): 1992.

The wind shield shall be designed for vertical loading, cross wind loading, seismic loading, circumferential wind loading, thermal gradients etc. ~~The various loading combinations shall be as detailed in IS:4998~~. The wind shield shall be analysed for cases with and without flue liner loads.

Forces/stresses in the wind shield due to eccentricity effects of local (e.g. corbel) loadings, insolations effects, rotation of chimney foundations, construction tolerances and moments of second order shall also be considered.

Seismic response of the chimney shall be computed by the response spectrum method. At least, the first five modes of vibrations shall be used for this analysis.

The cross wind analysis of the chimney shall be carried out irrespective of the value of the Scruton Number for the chimney and other empirical considerations which suggest structural immunity to cross wind oscillations.

The effect of the openings/cut-outs in the chimney shell shall be duly considered in the design of the windshield. The minimum thickness of shell shall not be less than 500mm.

The stresses for the shell design shall not exceed the limits given in Cl. 7.0 of IS:4998 (PART-I) 1975 for various combinations of loads, excepting the stress in concrete for the case of dead load + wind load which shall not exceed 0.30fck where fck is the characteristic compressive strength of concrete.

The minimum vertical reinforcement shall be 0.3% of the concrete area. The maximum spacing of the reinforcement bars shall not be more than 250 mm on each face. The minimum circumferential reinforcement shall be 0.2% of the concrete area. The maximum spacing of the reinforcement bars shall not be more than 200 mm on each face. The circumferential reinforcement in the top 3 meters of the windshield shall be twice that required from design forces. The clear cover to reinforcement shall be 50 mm.

There shall be a continuous ring of concrete shell without any opening for a height of atleast 5m below the soffit of flue duct openings.

There shall not be any reverse (outward) slope in the inside face of chimney shell. Where there is a sudden change in slope/ profile of the shell, the circumferential reinforcement shall be increased to twice the requirement as per the design in a circumferential band extending atleast 3m above and below such slope/profile change level.

The diameter of the reinforcing bar for the main vertical reinforcement of shell shall not be less than 25mm for a shell height upto the top level of flue duct opening.

Shell thickness between any two 10m reference levels shall not vary more than 150mm.

The minimum thickness of shell/closure wall at beam support recess/ opening locations shall be 100mm.

Grade of concrete for chimney shell, and other super structure shall be minimum M 30. Only OPC cement shall be used for Chimney shell and other super structure.

The final design shall be checked & verified by 'Wind Tunnel Test' and shall be conducted at a reputed institution. Dynamic interference effects due to additional chimney(s)/NDCTS's and other tall structures located in the area or in the future expansion stage of the project shall be determined along with the other topographical features of the local area through model test.

Flue Liners

The chimney flue liner cladding shall be made of 2 mm thick Titanium (Grade 2 as per ASME SB265) or C-276 alloy over 8 mm thick (minimum) mild steel base metal of flue liner. Cladding shall be done to achieve the required quality as per ASTM B 989-11. External surface of chimney shall be wrapped with 2mm thick Titanium / C-276 sheet over insulation.
The stack shall be designed as per the latest guide lines of EPRI Wet Stack design Guide. The design of wet ducts and stacks system shall consider the Stack liquid discharge (SLD), corrosion/ chemical attack, condensate collection system and its drainage etc.

The flue gas parameters & various operating conditions for selection of flue liner and the criteria of flue gas exit velocity for sizing the flue liner shall be as specified elsewhere in the specification.

~~The flue liner thickness shall be determined from functional and structural considerations. However, the minimum thickness of the flue liner shall not be less than 10 mm.~~

For flue liner with base metal as mild steel, the thickness of the base metal shall be determined from structural considerations. The thickness of any clad metal/coating/lining etc. provided on the base metal shall not be considered for computing the structural strength of flue liner. The minimum thickness of the mild steel base metal shall, however, not be less than that specified elsewhere in the specification.

Two manholes placed diametrically opposite shall also be provided in each flue at all internal platform levels.

The supporting/restraining arrangements of the liners should be such that expansion of the liners longitudinally or circumferentially is not restrained.

Clean-out door shall be provided below the flue for the removal of ash.

Internal Platforms

The platforms shall be designed for dead, imposed (live), erection work and other possible loadings and temperatures effects. These platforms shall provide support and lateral restraint to the steel liners and provide access for inspections and maintenance. Forces imposed on the floors due to lateral restraint of flues shall be enhanced aptly for impact effects. These platforms shall also be designed suitably for the liner erection works. The platform shall be made up of chequered floor panels supported on grid of structural steel beams. All beams shall have bolted connections. The maximum permissible deflection in main steel girders supporting flue liner shall be span/1000.

Internal Staircase

and a clear headroom of not less than 2100mm.

The staircase shall have a clear passage way width of not less than 800 mm. The riser height shall not be more than 175 mm and tread width shall not be less than 225 mm.

Foundation

The chimney foundation shall be designed for the most critical combination of forces and moments, resulting from all possible combinations of the various loadings from the chimney

system during all stages of constructions. The effect of water table shall be considered and the foundation shall be checked for overturning for minimum and maximum vertical loads. There should be no uplift under any portion of the foundation for any loading condition. Since chimney is a wind sensitive structure no allowance shall be made in the load carrying capacity of the bearing strata / piles under any load case/combination with wind. No allowance shall be made in the stresses for design of foundation for wind loading. The foundation diameter to depth ratio shall be maintained to around 10 and should preferably not exceed 12. The diameter of the reinforcing bar for the main radial and tangential reinforcement for the foundation shall not be less than 25mm. The spacing of radial steel at the outer edge of the foundation shall not be more than 250mm. Grade of concrete for foundation shall be minimum M 25.

Thermal insulation

The insulation shall be semi-rigid, resin bonded type, in the form of slabs and shall conform to IS: 8183. Blanket type insulation shall not be used. The density of insulation shall not be less than 64 kg/cu.m for resin bonded glass wool insulation and 100 kg/cu.m for resin bonded rock wool. The coefficient of thermal conductivity of insulation shall not be more than 0.52mW/cm/oC at a mean temperature of 100oC.

The insulation thickness shall be determined based on the maximum ambient temperature, surface air velocity worked out based on the draught of ventilation air in the annular space between the flue liner and chimney shell, insulation surface emissivity of 0.3 and the insulation cold face maximum temperature not exceeding 55 degree Celsius. The draught of air in the annular space shall be the natural draught created by the heating of air by the flue liner and the air being vented out through the openings in the chimney shell. The increase in the annulus air temperature due to the rising heated air shall be taken into account while calculating the insulation thickness.

The insulation thickness shall not be less than 100 mm, in any case, and shall be provided in two layers with the second layer of insulation covering the joints of the first layer. The insulation shall be wrapped on the outer-most surface with galvanised wire mesh using MS galvanised pins and speed washer.

Chimney Painting

(i) All exposed steel surfaces (~~including exterior surface of mild steel flue liner~~) except surfacesof steel wind strakes shall be painted as specified in corrosion protection clause of this specification.

(ii) All exposed surfaces of steel wind strakes shall be painted with epoxy phenolic coating system having total 240 microns DFT.

a) All steel surfaces shall be provided with two component epoxy primer coat (having solid by volume minimum 51% ±2%) of minimum 70 micron DFT to be applied over blast cleaned surface conforming to Sa 2 ½ finish of ISO 8501-1 with surface profile 40-60 Micron. The primer coat shall be applied in shop immediately after blast cleaning by airless spray technique.

b) Primer coat shall be followed with the application of Intermediate coat of epoxy phenolic coating (solid by volume minimum 63%) of minimum 100 micron DFT. This coat shall be applied in shop after an interval of minimum 24 hours (from the application of primer coat) by airless spray technique.

c) Intermediate coat shall be followed with the application of finish coat of two-pack aliphatic Isocyanate cured acrylic finish paint (solid by volume minimum 55% ±2%) with Gloss retention (SSPC Paint Spec No 36, ASTM D 4587, D 2244, D 523) of Level 2 (after minimum 1000 hours exposure, Gloss loss less than 30 and colour change less than 2.0 ΔE) and minimum 70 micron DFT. This coat shall be applied in shop after an interval of minimum 10 hours and within six (6) months (from the completion of Intermediate coat), Colour and shade of the coat shall be as approved by the Employer.

(iii) All steel parts embedded in concrete like Strake embedment assembly including bolts, nuts, washers, pipe sleeves and insert plate shall be galvanized as per IS:4736. The minimum weight for galvanizing shall be 610 gm/sq.m and shall comply with relevant IS Codes.

(iv) The inside surface of chimney shell above roof, horizontal surface of sheel at top, underside of concrete roof slab, external surface of minishell above roof etc shall be painted with epoxy phenolic coating system having total 220 microns DFT.

a) All concrete surfaces shall be provided with two component transparent polyamide cured epoxy sealer coating (having solid by volume minimum 40% ±2%) of minimum 50 micron DFT to be applied over cleaned surface in multiple coats. Surface to be coated shall be absolutely dry, clean and dust free.

b) Sealer coat shall be followed with the application of Intermediate coat of epoxy phenolic coating (solid by volume minimum 63%) of minimum 100 micron DFT. This coat shall be applied after an interval of minimum 24 hours (from the application of primer coat) by airless spray technique.

c) Intermediate coat shall be followed with the application of finish coat of two-pack aliphatic Isocyanate cured acrylic finish paint (solid by volume minimum 55% ±2%) with Gloss retention (SSPC Paint Spec No 36, ASTM D 4587, D 2244, D 523) of Level 2 (after minimum 1000 hours exposure, Gloss loss less than 30 and colour change less than 2.0 ΔE) and minimum 70 micron DFT. This coat shall be applied ~~in shop~~ after an interval of minimum 10 hours and within six (6) months (from the completion of Intermediate coat), Colour and shade of the coat shall be as approved by the Employer.

(v) The top 50 M of the external surface of chimney shell shall be painted with epoxy phenolic coating as specified in (iv) above in alternate bands of 'signal red' and 'bright white' colours.

(vi) The balance external surfaces of chimney shell with aliphatic acrylate system having total 170 microns DFT.

a) All concrete surfaces shall be provided with two component transparent polyamide cured epoxy sealer coating (having solid by volume minimum 40% ±2%) of minimum 100 micron DFT to be applied over cleaned surface in multiple coats. Surface to be coated shall be absolutely dry, clean and dust free.

b) Sealer coat shall be followed with the application of finish coat of two-pack aliphatic Isocyanate cured acrylic finish paint (solid by volume minimum 55% ±2%) with Gloss retention (SSPC Paint Spec No 36, ASTM D 4587, D 2244, D 523) of Level 2 (after minimum 1000 hours exposure, Gloss loss less than 30 and colour change less than 2.0 ΔE) and minimum 70 micron DFT. This coat shall be applied ~~in shop after an interval~~ of after an interval of minimum 24 hours (from the application of sealer coat).
Colour and shade of the coat shall be as approved by the Employer.

Electrical System

415V, normal and emergency AC power supply for chimney shall be derived from main plant power supply system. Emergency supply shall feed 20% of platform lighting, 50% of staircase lighting, aviation obstruction lighting and elevator load. All other loads shall be connected on normal power supply.

Ambient temperature for design of all equipment shall be considered as 55 deg. C which is likely to be encountered inside the chimney. The equipment shall be suitable for installation and render trouble free operation at higher ambient temperature and rigorous weather conditions prevailing at chimney.

All equipment supplied shall comply with relevant IS Standards.

The distribution boards of chimney shall comprise switch fuse units of appropriate ratings. Emergency board shall have two incomers, one from emergency supply and other from

normal AC distribution board itself. Auto changeover scheme shall be provided in emergency board to enable changeover to healthy source on failure of any source.

Dry type isolating transformer of Dyn connection shall be provided in emergency board to obtain neutral lead, in case 3 phase 3 wire emergency supply is derived from main plant.

Various platforms shall be illuminated by dust tight HPSV well glass lighting fixtures. Average illuminations level of 150 lux shall be maintained on equipment and 70 lux on platforms & 100 lux on staircases (minimum 1 lighting fixture at each landing).Any additional fixture to take care of dark patches/shadows shall also be provided. Lighting system shall be controlled through MCB provided in lighting panel.

A lighting and power panel each shall be located at grade level and at other in between levels as required. All distribution boards, aviation lighting controls, etc. shall be located at grade level only. At each platform, 1 No. 63A, 415V welding receptacle and 1 No. 20A, 240V receptacle shall be provided and shall be fed from power panel. Wiring installation for lighting fixture shall be of PVC insulated copper/aluminium wires through galvanised steel conduits.

Aviation obstruction lighting system shall conform to the requirements of the latest rules and regulations of the International Civil Aviation Organization (ICAO), National Airports Authority (NAA) and Directorate of Air Routes and Aerodromes (DARA). The type of aviation obstruction lighting system shall be of high intensity aviation obstruction lights having an effective intensity of 4000 to 2, 00,000 cd depending upon back ground illuminance. Obstacle lights shall have a day time effective intensity of minimum 200000 cd. The intensity of lights shall reduce automatically to 20000 cd ± 25% at twilight through the use of photocell and again automatically to a night time intensity of 4000 cd ± 25% through the use of photo-cell. The obstacle lights shall flash simultaneously at a rate between 40 to 60 per minute. A minimum of three levels will be provided with aviation obstruction lights and there will be four light units per level. The lowest level should not be lower than 70 meters above the ground and vertical spacing of the intermediate levels could vary between 70 and 105 meters. Aviation obstruction lighting shall be complete with lights, photo cell, controller, special cables, etc.

A temporary aviation obstruction lighting system shall be provided during construction of the chimney.

Cables from distribution board to lighting panels/power panels/receptacles shall be 1100V grade, multicore FRLS HR-PVC insulated, PVC inner sheathed, armoured, PVC outer sheathed stranded copper/ aluminium laid on galvanised sheet steel cable trays. Cables shall be terminated using double compression type cable glands and solder less crimping type tinned copper cable lugs. Minimum size of the power cable shall not be less than 2.5 sq.mm copper or 4 sq.mm aluminium. Minimum size of control cable shall not be less than 1.5 sq.mm.

Lightning protection system shall comprise minimum 3 vertical air terminations for each flue liner, horizontal air terminations and minimum 4 Nos. of down conductors spaced 90 degrees apart routed all along chimney height on external surface and connected to the earthing system. Down conductors shall be of minimum 50x6 mm galvanized steel strip. Each down conductor shall be provided with a test link at 1 metre above ground level. Each test link shall be enclosed in a galvanised sheet steel enclosure. Above ground level earthing and lightning protection system shall comprise galvanised steel strips. These materials provided at top 12 meters shall have additional coating of 2 mm thick seamless lead cover and the accessories like nuts, bolts, washers etc. shall be of stainless steel to take care of corrosion. Chimney earthing system shall be interconnected to main plant earthing system.

A temporary lightning protection &earthing system shall be provided during construction of the chimney till a permanent lightning protection &earthing system is installed. In no case reinforcement bars of Shell should be used as earthing Down Conductors

Communication system comprising of telephone socket at every internal platform level and at grade level, necessary wiring installation, a telephone hand set, junction boxes etc. shall also

be provided. Telephone cables shall be of minimum 0.6 mm dia annealed high conductivity electro copper conductor, PVC insulated, twisted, PVC tape wrapped, screened, rip corded, PVC sheathed, conforming to relevant ITD (Indian Telephones Department) specifications.

All equipment to be supplied shall be of type tested quality. The Contractor shall submit for Owner's approval the reports of all type tests as listed below:

(A) Distribution boards/panels-Degree of protection tests

(B) Aviation lights:

(1) Intensity Test

(2) Degree of protection test

For various equipment, the technical requirements and practices shall conform to the relevant clauses of the main plant electrical specification.

Rack and Pinion Elevator

A rack and pinion elevator, with a load carrying capacity of 400 kg (min) (passenger cum goods), cabin floor size of 1100 mm x 1000 mm (min.) and an operating speed of 40 m/min. (approx.), shall be provided for travel from the grade level to the top of the chimney. A landing platform shall be provided at all access/ platform levels. The elevator shall be of a proven and approved make. Enclosure shall be fabricated from tubular steel and expanded metal or wire mesh, 2.1 m high (Approx.). A Safety device comprising of an over speed governor in constant mesh with the rack by means of a flame hardened steel pinion shall be provided to protect the cab against over speed during the cab downward motion and the same shall actuate the brake mechanism and stop the down ward motion gradually. The lift shall be installed using anchor fasteners. The electrical requirement of the system shall conform to the main electrical specification. Drive motor shall be of S3 duty class with CDF of 25% and maximum number of 120 starts per hour in 55 degree Celsius ambient temperature. The motor shall be provided with internal 220V AC single phase space heaters or an alternate heating system. The elevator shall be supplied, installed, painted, tested, commissioned etc. complete with all mandatory spares (as specified in Part-F of this specification) and operation maintenance manual.

5.03 Auxiliary Cooling Tower

5.03.01 RCC/FRP Auxiliary Induced Draught Cooling Towers

The civil works for cooling towers are related mainly to following areas, but not limited to:

5.03.01.01 Cooling TowerBasin

The basin of the cooling tower for collection of cold water shall be made of Reinforced Cement Concrete (RCC M - 30 grade as per IS: 456). The floor of the basin shall be sloped to minimum 1 in 80 towards the sludge drains. The required slope shall be achieved by screed concrete of grade M-15 as per IS:456 having minimum thickness at edge as 25 mm. Drainage arrangement of basin shall be as specified elsewhere in the Technical Specifications. If the cooling tower basin and sludge sump is below ground level, FRP handrailing shall be provided all around the cooling tower basin and sludge sump pit.The bottom 500 mm of handrailing shall also have FRP/PVC wire mesh with opening size of 50mm grid to avoid ingress of leaves, vegetation, and debris into the basin. The basin shall be tested for water tightness as per IS:3370.

~~Bottom of the lowest level beam shall be at least at free board level. In case, the beams are provided into the water, the same shall be designed for un-cracked section as per IS:3370~~.

Hot water duct around cooling towers, if placed below ground shall be encased with min. 500mm thick PCC (M20 grade).

a) Foundation of Cooling Tower

The foundation of the Cooling Tower shall be as detailed out elsewhere in the specifications.

b) Super Structure of Cooling Tower (applicable in case of RCC cooling tower)

Columns, beams and other structures like tie beams, slabs etc. shall be of reinforced cement concrete of grade M-30 (minimum) as per IS : 456. Uniform concrete grade shall be used for the entire cast-in-situ reinforced concrete superstructure.

The fan deck slab shall be properly sloped so that rain water does not accumulate over the deck slab. The slope shall be 1 : 120 (min.). The slope shall be provided with screed concrete of grade M-15 (minimum) as per IS : 456.. Fan Deck slab and all other over ground platforms shall be provided with FRP handrailing. Suitable arrangement for drainage of rain water to be provided. However, there is no specific requirement of Rain Water down comers.

c) Cells, Distribution System and Stack (applicable in case of RCC cooling tower)

Cooling tower cells shall consist of RCC columns, beams and walls. The spacing of columns shall be minimum 4000 mm c/c. Inclined bracings shall not be provided between the columns. Hot water distribution channel shall also be of RCC. Cell division partition walls shall be of precast solid concrete blocks with provision of pilasters for walls, if required. The peripheral wall shall be Cast-in-Situ RCC wall and shall have two layers of reinforcement on either faces in both directions with minimum dia of reinforcement bars as 8 mm and maximum spacing as 150 mm c/c. Minimum thickness of Cast-in-Situ RCC peripheral walls shall be 200 mm.

Hot water channel shall be covered with suitably designed precast / cast - in - situ concrete slab. Wherever flow control valves are located over hot water basin, these shall be placed over precast concrete covers / concrete slab and designed for specified load. The minimum thickness of RCC fan stack shall be 150 mm. The fanstack shall have two layers of reinforcement on either faces in both directions with minimum dia of reinforcement bars as 8mm and maximum spacing as 200mm c/c.

d) Stairs

FRP staircase for approach to fan deck for each cooling tower shall be provided. The stairs shall have 1000 mm clear width and FRP handrailing. The riser shall be maximum 175 mm & treads 250 mm (minimum).

e) Steel Structures

~~All mild steel parts of structures used in cooling towers shall be hot dip galvanized or seal spray zinc coated as per BS:5493 (for a very long period of maintenance of more than 20 years). The minimum coating for galvanization shall be 610 gm/sq.m and shall comply with relevant IS Codes. Galvanizing shall be checked and tested in accordance with IS: 2629. All welding shall be done before galvanizing. Any site joints required to be carried out after galvanizing shall be either flanged or screwed joints. Nails, nuts, bolts and all components coming in direct contact with water shall be of stainless steel of SS 316.~~

f) Water proofing of structures and construction joints

For water proofing of underground structures including basin slab and hot water distribution channel, water proofing cum plasticizer compound shall be mixed with the concrete. In addition Chemical injection treatment shall be provided for the construction joints of all underground structures.

g) Expansion Joints

PVC sealing strips shall be used for all expansion joints where water is retained. The minimum thickness of PVC sealing strip will be 6 mm (minimum) and minimum width 225 mm. The expansion joint shall be as per IS: 3370. At expansion joints, joints filler material with sealing compound on both sides shall be provided throughout the length of the joint.

h) Grade of concrete

All RCC associated with induced draught cooling towers including switchgear and control room, unless specified otherwise, shall be design mix (controlled) concrete of grade M 30 of IS: 456. Water - cement ratio shall not exceed 0.45.

Minimum 75 mm thick PCC of grade M-7.5 as per IS: 456 shall be provided as mud mat below foundation unless specified otherwise. The PCC shall extend 75 mm beyond the outer edge of structural concrete.

For water retaining structure minimum 100 mm thick PCC of grade M-10 as per IS:456 shall be provided as mud mat below the bottom slab / raft. The PCC shall extend 100 mm beyond the outer edge of the structural concrete.

i) Form-Work

Plywood Form-work shall be used for basin, basin walls, outlet channel and super structures (if applicable).

j) Doors

FRP door shall be provided in each fan stack at fan deck level. Door height & width as per requirement for equipment movement (clear) shall be provided. However, door size shall be minimum 2100 mm high (clear) & 1200 mm wide (clear). Door shall have locking facility.

k) Coating

All concrete surfaces in direct contact with water/ water spray/moist air shall be applied with Moisture Compatible Corrosion Resistant Coating System or its equivalent as specified in **Annexure-H.** All concrete surfaces subject to water/ water spray/moist air upto and including Fan Deck slab level including basin slab, inner faces of peripheral walls, all faces of cell partition wall, all faces of columns, all faces of beams (both cast in situ and precast), bottom surface of fandeck slab for counter flow tower and both surface of fandeck slab for cross flow tower, inner face of fanstack, all faces of hot water basin (for cross flow tower), etc as applicable shall receive the said coating after cleaning and drying of the concrete surface. The detailed specification of the coating system on concrete surfaces is given in **Annexure-H.**

External surfaces of Cooling tower peripheral walls and fanstack shall be painted with two or more coats of waterproof cement paint of approved shade, make and color. (applicable in case of RCC cooling tower)

l) Paving

Paving shall be provided for a minimum clear width of 5.0 m from the outer face of the HW pipes all around the cooling tower basin. Paving shall also be provided in between the hot water pipes and space available between HW pipes and CT basin wall spray catcher. The minimum total width of paving around CT basin shall be atleast 8.5 m from outer edge of the spray catcher or basin wall. Paving shall consist of reinforced concrete base slab laid over 75 mm thick PCC of grade M-10 as per IS:456 sub-base and 200 mm thick stone soling. The sub-base shall be laid on the compacted and suitably prepared sub-grade. The degree of compaction of sub-grade shall be as specified elsewhere in the specification. The thickness of the RCC base

slab of grade M - 25 shall be suitably designed considering a superimposed load intensity of 5T / Sq.m. However the minimum thickness of base slab shall be not less than 150 mm having double layered reinforcement in both directions both top and bottom. The maximum spacing of the reinforcement bars shall be 150mm c/c and minimum dia of reinforcement bars shall be 8mm.

RCC peripheral drain of minimum cross sectional dimensions 300mm X 300mm to dispose storm water shall be provided around area paving and shall be connected to nearest Owner's storm water drain.

m) **Walkways (applicable in case of RCC cooling tower)**

Permanent walkways at least 1000mm clear width shall be provided at hot water distribution level and at drift eliminator level for counter flow type cooling towers. The clear working height available above these walkways shall be at least 2.0 meters. The walkway and its supporting structure shall be of RCC M - 30 grade. Suitable RCC guards rails 300 mm high shall also be provided on both sides of these walkways. Over the guards rails FRP handrailing shall be provided. The vertical post of handrail shall be 700 mm high and at an interval of 1500mm c/c. There shall be two levels of horizontal pipes for hand railing spaced equally in vertical plane.

Permanent walkways at least 1000 mm clear width shall also be provided for access to fan and around gear box with FRP gratings of clear opening size not more than 50 MM x 50 mm and grating thickness of 50 mm on RCC supports at fan deck Level.

5.03.01.02 **Design Criteria**

R.C.C. Structures

(a) The design of all liquid retaining/conveying structures of cooling tower like C.W. basin, sump, hot water distribution channel/basin, sludge drain and pits shall be designed by working stress method as outlined in Clause 4.5 of IS 3370 (Part 2) : 2009. These structures shall be designed for following conditions :-

1. Water filled inside upto the designed level and no earth outside.
2. Earth pressure plus 2.0 T / M2 surcharge (Vertical direction) plus ground water table at Finished Graded ground Level (FGL) outside and no water inside.

(b) The design of all structures other than liquid retaining/conveying structures of cooling tower above CW basin slab such as columns, beams, fins, walkways, slabs, cladding/partition wall, fan stack, precast beams etc. as applicable shall be carried out by limit state method as outlined in Clause 4.4 of IS: 3370 (Part 2): 2009. Further, for limiting the crack width, the stress for the reinforcement steel shall be limited to 130 MPa (on all faces) as per clause 4.4.3.1 of IS: 3370 (Part 2): 2009 using the partial safety factor for serviceability condition as per clause 4.4.1.3.

Wherever, the foundation raft of cooling tower is same as CW basin slab, the foundation shall be designed by working stress method as outlined in Clause 4.5 of IS 3370 (Part 2): 2009 (all faces). However, if the cooling tower foundation is not the same as the CW basin slab and a separate foundation for the cooling tower is provided below the CW basin slab due to founding level requirements, the basin slab shall be designed as a structural slab resting on grid of beams taking support from columns or as a flat slab taking support from columns. Arrangement with providing walls between the columns and the periphery to support the structural basin slab is not permitted. The CW basin slab (both faces, including beams at CW basin slab level) shall be designed as structural slab by working stress method as outlined in Clause 4.5 of IS 3370 (Part 2): 2009 andthe structures below CW basin slab shall be designed as per IS:456 (2000). However, the size of the column below CW basin slab upto foundation shall be maintained same as the size of the columns just above CW basin slab..

(c) The design of staircase, switchgear building, control room/RIO room, transformer and trestle foundation, storm water drain shall be as per IS: 456 (2000).

(d) The Cold Water basin shall be checked against uplift for basin empty condition with ground water table at FGL. Stability against uplift shall be ensured both for construction & operating stage with no water inside. The provision of flap valve / pressure release valves is not permitted. The factor of safety against uplift shall be as per IS: 3370.

(e) Fan deck shall also be designed for rolling loads due to movement of equipment during Installation / maintenance operation.

Minimum Clear cover for all RCC structures/elements of cooling towers to meet durability requirements shall conform to severe exposure condition as per IS: 456 (2000).

Fan Supporting Structures (applicable in case of RCC cooling tower)

Static Analysis & Design

The following load conditions and load combinations shall be considered for the design of the Fan supporting structures.

(a) Machine Load

(b) Load case (a) + unbalance load for the balance of the fan corresponding to G16 as per ISO 1940-1: 2003

(c) Load case (a) + unbalance load corresponding to one blade failure load condition.

The strength design of the Fan supporting structure shall be done for worst loading combinations as stated above.

Dynamic Analysis

(a) Free vibration analysis

A free vibration analysis of the fan supporting structure including the intermediate supporting structure for motor, gear box and pillow block (if applicable) shall be carried out to calculate the natural frequency of the fan supporting structure and its fundamental natural frequency shall be at least + 20% away from the operating speed of the fan and motor.

(b) Forced vibration analysis

Forced response analysis shall be carried out on the fan supporting structure including the intermediate structure supporting the motor, gear box and pillow block to calculate the vibration amplitudes for the following unbalance condition : -

1. For unbalance load corresponding to G16 as per ISO 1940-1: 2003
2. For unbalance load corresponding to one blade failure condition.

The amplitude derived shall be within the permissible values as specified by the fan manufacturer or IS: 2974 (Part - IV), whichever is more stringent.

Mid Bearing Supporting Structure

The intermediate supporting structure for motor, gear box and pillow block if provided shall be so arranged that it does not cause any torsional moments on the beams / pedestals on which the intermediate support rests. The intermediate supporting structure shall be orthogonal to the grid of beams on which it rests. The motor shall be supported on a base frame. The concrete block supporting the fan/gear reducer shall be connected to immediate lower level of beam column junctions by means of at least four diagonal columns.

Fan Stack (applicable in case of RCC cooling tower)

The fan stack shall be made of RCC with minimum 150 mm thickness. With reinforcement provided on both faces in either direction. Design of the fan stack shall be made on the basis of relevant stipulations of IS : 11504 for Natural Draught Cooling Towers. The fanstack shall have two layers of reinforcement on either surfaces in both directions with minimum dia of reinforcement bars as 8mm and maximum spacing as 150mm c/c.

Steel Structure

(except structural steel parts for stop-log gates and trash racks)

All mild steel parts or structural steel works used in the cooling towers shall be hot dip - galvanised as per IS: 4759 with 610gm/sq.m. coating or seal spray zinc coated as per BS:5493 (for a very long period of maintenance of more than 20 years). Nails and all components coming in direct contact with water shall be of stainless steel of SS 316 or equivalent.

All welding shall be done before galvanizing. Any site joints required to be carried out after galvanizing shall be either flanged or screwed joints

For all steel structures, other than hot water pipes, sludge pipes and hot water distribution pipes, which are outside cooling tower painting shall be as specified in corrosion protection clause. However, for painting of hot water pipes, sludge pipes and hot water distribution pipes, relevant clause for painting specified elsewhere in the technical specification shall be referred.

The minimum cement content as specified in subsequent clauses of this specification shall be applicable for all structures of cooling towers.

Test for water tightness

The water tightness of C.W. basin, outlet channel, hot water channel and all other water retaining structures shall be tested for water tightness as per the provisions of IS : 3370.

5.03.01.03 LOADING

For consideration of loads on structures and load combinations IS : 875 (Part -1 to 5) Code of Practice for design loads (other than Earthquake) for Buildings and Structures shall be followed.

Site specific seismic data and wind data shall be followed for design of cooling towers.

Live Loads

The following live loads (minimum) shall be adopted for the design of buildings and structures associated with Cooling Towers:

a)	Roof / Fan deck	500 Kg / Sq. M.
b)	RCC Floors	500 Kg / Sq. M.
c)	Stair, landings	500 Kg / Sq. M.
d)	Chequered& Grating floor	400 Kg / Sq. M.
e)	Basin, sump and duct	Earth pressure; water pressure as applicable and additional surcharge load of 2.0 T/Sq. M.
f)	Covers for H.W. channels / H.W. distribution basin	300 Kg / Sq. M.
g)	Walkways inside cooling towers	300 Kg / Sq. M.

	h)	Underground pipes and ducts	Earth pressure and surcharge load of 2.0 T / Sq. M.

5.03.02 STOPLOG GATES AND TRASH RACK FOR COOLING TOWER

Stoplog gates

The stoplog gate shall cover the clear opening of the cold water channel and effectively stop the water leakage. Clear size of the stoplog gates shall be equal to the clear opening size (freeboard of minimum 300mm over the maximum water level in stop log depth shall be ensured.). The capacity of the hoist (Min 2 ton capacity) shall be decided to match with provided size units of the stoplog gate. Structural design of stoplog gate shall conform to IS : 5620 and IS : 4622 (latest). Maximum water level for designing the stoplog gates shall be taken as maximum water level in the CT basin.

Stoplog gate and its lifting arrangement shall designed for a condition when basin is empty and water upto full level on the other side. Proper rubbers seal shall be provided in the stoplog to avoid any leakage of water.

Painting Specification for Structural Steel parts for stoplog gates and trash racks:

(i) All structural steel surfaces shall be cleaned by shot blasting.

(ii) All MS structural parts shall be galvanised to minimum coating of Sealed Zinc spray (250 Micron) as per BS:5493.

(iii) Over zinc coating one coat of zinc Phosphate Epoxy primer having minimum 30 micron DFT and three coats of coal tar Epoxy paint having minimum 75 micron DFT / coat shall be provided. Total DFT of epoxy paint including primer shall be minimum 250 microns.

Leakage Tests of Stoplog Gates

Leakage tests shall be carried out with the stoplog gates lowered onto the sill. Before observation for leakage, the stoplog gate shall be raised and lowered about one meter several times in order to dislodge any debris that might have lodged in the side and bottom seals, The leakage shall then be measured and it should not be more than 5 Liters / Minute / Meter length of seal under maximum head.

Material Specifications of stop log gate

All material used in the fabrication of stoplog gate shall be of high grade, free from defects and imperfections and shall be of the highest standard commercial quality suitable for the intended use. Radiographic examination or magnetic particle testing or other comparable tests shall be carried out for determining the soundness of steel castings and shall be conducted by the Contractor, if asked for by the Employer.

Materials for the various components of Stoplog gates

Sl. No.	Component Parts	Recommended Materials	Reference
1.	Stoplog Gate Leaf	Structural steel	IS : 2062
2.	Stoplog Gate Frames and 1st stage embedded parts	Structural steel	IS : 2062

3.	2nd stage embedment	Stainless steel	SS 316L or IS : 1570 (Part 5).
4.	Wheels (the hardness of wheel track surface shall be kept 50 points higher than that of wheel tread)	Cast steel	IS : 1030
5.	Wheel axles, wheel track	Corrosion resistant steel.	IS : 1570
6.	Seals	Rubber	IS : 11855
7.	Bearings	SKF of equivalent	04 Cr 19 Ni)
8.	Seal seats	Stainless steel	SS 316 L or IS 1570 (Part -5)
9.	Lifting pin	Stainless steel	IS 1570 (04 Cr,
10.	Guide	Corrosion resistant steel	IS : 6603
11.	Guide shoe	Structural steel	IS : 2062
12.	Counter sunk bolts	Stainless steel	IS:1570 (Part 5)

TRASH RACKS

Materials, Manufacture and Design

Material Specifications:

All materials used in the fabrication of equipment required shall be new and shall conform to the requirements of specifications and codes as applicable referred herein. If a material is specifically not referred to in these specifications/specification drawings, Contractor shall furnish material of the highest standard commercial quality suitable for the intended use.

The material referred to in the design and drawings mostly conform the Indian Standard Specifications unless otherwise stated:

Materials for Trash Racks

S.No.	Component/Part	Recommended material	Reference
1.	Trash rack and embedded parts	Structural Steel	IS-2062

2.	Slide block	Structural Steel with bronze padding	IS-2062 and IS:305
3.	Track base	Stainless Steel	SS 316L or IS : 1570 (Part 5)
4.	Track	Stainless Steel	SS 316L or IS : 1570 (Part 5)
5.	Guides	Corrosion resistant Steel	IS : 6603
6.	2nd stage embedment	Stainless steel	SS 316L or IS : 1570 (Part 5)

2.Minimum Draw Down Level = RL(+)387.7m
3. Centerline of existing header pipe = Approx. RL (+) 382.00m.
Associated civil works include civil works of Civil works associated with Make-up water _PT and Makeup water-Ash pump house. Including pump foundations, sumps, Cable trenches/cable tray supports, pipe supports, grade slab & area paving, pedestals/thrust blocks for pipes(both inside and outside the plant boundary), arrangements for Makeup water pipe crossing at nallah/river/road/rail/drains locations and other associated civil works as per system requirements. The details and design criteria of water retaining structures like sumps, channels etc. associated with Makeup water pumphouse shall be as specifed clause No 5.05 of this chapter.

Design

Trash rack should be designed for 2.0m differential head as per IS:800 and also conform to IS:11388 (latest). Each unit of trash rack shall be consisting of vertical flats and horizontal flats. The grating shall be pressure locked. Size of opening shall be 100 mm x 100 mm for all trash racks.

All trash rack should be capable of being lowered in the associated stoplog gate grooves to enable drawl of clean water while a particular track rash is raised for cleaning purposes.

~~Trash racks shall be hot dip galvanized as per IS:4759 with 610 gm/sqm coating. Alternatively, trash racks shall be painted with sealed spray zinc coating conforming to BS:5493 (Table – 3, Part 8) for very long (20 or more) years of maintenance interval~~.

5.03.03 **Switch Gear / Control Room for Cooling Tower**

It shall be single storied building, framed RCC structure with beams, columns, floor and roof. It shall have non-load bearing brick wall cladding. It shall house the switch gear and MCC of cooling tower & associated cable trenches. It shall have toilet block with drinking water facility. The architectural features shall be as specified elsewhere in the specification.

5.04 **ACW SYSTEM AND MAKEUP WATER SYSTEM**

5.04.01 Open pumphouse including pump foundations, cable trenches/cable tray supports, pipe supports, grade slab & area paving, gantry crane pedestal and other associated civil works as per system requirements shall be provided for ACW system.

5.04.02 Suitable arrangement shall be made for interconnection of Makeup water pipes with existing header downstream of intake chamber (situated near spill way of Patratu dam and laying of make -up water pipe line up to PT plant and Ash handling plant. Any dismantling works required for enabling interconnection shall be carried out carefully to prevent damage to other nearby structures/ares and without disturbing the existing system operation. A closed valve chamber with locking facility shall be provided near the interconnection point for housing the valves provided in the Makeup water pipes under bidder's scope.
Salient features of Patratu Dam are as follows:
1. Maximum water level = RL(+) 406.14m

5.05 **Water & Effluent Treatment Plant and CPU Civil Works**

5.05.01 **Design Concepts for Buildings/ Shed**

i. All buildings shall have framed super structure.

ii. Equipment/facilities with shed shall have structural steel superstructure with permanently colour coated metal sheeting at roof and on all sides. However, kerb wall shall be provided all around the plinth/ floor area above the Finished Floor Level (FFL). For other buildings brick wall cladding on exterior face shall be provided.

iii. Unless specified, the wall cladding for buildings shall be with minimum one brick thick on exterior face. However, brick wall for buildings adjacent to transformers shall be minimum 345mm thick.

5.05.01.01	Individual members of the frame shall be designed for the worst combination of forces such as bending moment, axial force, shear force, torsion, etc.
5.05.01.02	The load and load combinations and design criteria shall be as specified elsewhere in the specification.
5.05.01.03	All liquid retaining structures shall be designed for following load conditions. Underground structures: a. Water filled inside up to design level and no earth outside. b. Earth pressure with surcharge of 2.0 T/m2 and ground water table up to FGL outside and no water inside. c. Stability against uplift shall be checked for completed structure and under construction stage with no water inside and ground water table up to FGL, with a minimum factor of safety of 1.20 against uplift. Installation of pressure relief valves shall not be permitted in the base slab of any liquid retaining / conveying structure. d. The structure shall also be checked for normal working condition with water filled inside up to design level and earth pressure outside with no effect of surcharge and ground water table. For design of over - ground liquid retaining structures appropriate load cases shall be considered.
5.05.01.04	All liquid retaining and conveying structures shall be designed by working stress method as given in clause 4.5 of IS 3370(Part2):2009.
5.05.01.05	In the wall of liquid retaining structures with cylindrical shape such as clarifiers, vertical reinforcement shall be checked assuming the walls were fully fixed at the base, and the horizontal reinforcement shall be provided to resist horizontal (hoop) tension assuming hinged condition at the junction of the base slab & wall.
5.05.01.06	Wherever sandwich slabs are provided in liquid retaining structures to take care of stability against uplift, only well graded sand of approved quality shall be used as fill material. The sand compaction shall be done with plate / disc compactors in such a manner that the bottom slab is not structurally damaged.
5.05.01.07	Clear free board of at least 300 mm above design (total) water level shall be provided in all liquid retaining / conveying structures.
5.05.01.08	Coefficient of active earth pressure shall be considered for design of free standing retaining walls and coefficient of earth pressure at rest shall be considered for design of top propped retaining walls.
5.05.01.09	The minimum grade of concrete for all RCC structures shall be M30.The minimum concrete clear cover to reinforcement bars in all RCC structures shall be as per IS:456(2000) and IS:3370(Part II) for water retaining structures. Durability of concrete shall conform to severe exposure conditions as per Table-3 of IS 456 except noted specifically otherwise.
5.05.01.10	Factor of safety against overturning and sliding The structure shall be checked for minimum factor of safety of 1.5 against overturning conditions (ratio of stabilizing moment to overturning moment) and 1.4 against sliding conditions as per IS: 456.
5.05.01.11	For detailing of Reinforcement IS 5525, IS 13920, IS 4326 and SP 34 shall be followed.
5.05.01.12	Two layers of reinforcement (on both faces) shall be provided for RCC sections having thickness of 150 mm and above.
5.05.01.13	Minimum diameter of main and distribution Reinforcement bars in different structural elements shall be as follows:

Sl. No.	Structural Element	Main Reinforcement	Distribution Reinforcement / Stirrups/ ties/ Anchor Bars
a)	Foundation	12 mm	12 mm
b)	Beams	12 mm	8 mm
c)	Columns	12 mm	8mm

5.05.01.14 Spacing of reinforcement bars in walls and slabs of liquid retaining / conveying structures shall not be more than 200 mm.

5.05.01.15 Suitable shrinkage reinforcement shall be provided at top face of foundations. Minimum shrinkage reinforcement shall be 10 mm dia. @ 200mm c / c.

5.05.01.16 Minimum Reinforcement in all elements of liquid retaining / conveying structures shall be 0.24 % of cross sectional area.

5.05.01.17 Minimum tensile Reinforcement in each direction for all foundation slabs / rafts shall be 0.2% of cross sectional area.

5.05.01.18 Minimum thickness of foundation slab / raft and base slab of all liquid retaining tanks / pits shall not be less than 250 mm.

5.05.01.19 Minimum thickness of all elements of RCC liquid retaining / conveying structures (except effluent drains, launders and aerator waste slab) shall be 200mm. Effluent drains (depth more than 500mm), aerator waste slab and launders shall have minimum element thickness of 150mm.

5.05.01.20 All Insert plates (except edge protection angles) provided in liquid retaining structures shall be 12 mm thick GI with lugs not less than 12 mm diameter. Edge protection angles shall be provided as specified elsewhere.

5.05.01.21 All water retaining structures shall be tested for water tightness as per provisions of IS: 3370 and IS: 6494.

5.05.01.22 2.0m wide walkway with concrete paving shall be provided connecting all structures, buildings and facilities. The top of walkway shall be minimum 200mm above FGL.

5.05.01.23 Coating on RCC water retaining structures (other than drinking water)

Epoxy phenolic coating shall be applied on (i) internal surfaces of the RCC water retaining structures and (ii) external surfaces of RCC Neutralisation-pit which is in contact with earth, as per details specified below:

a) All concrete surfaces shall be provided with two component transparent polyamide cured epoxy sealer coating (having solid by volume minimum 40% ±2%) of minimum 50 micron DFT. Surface to be coated shall be absolutely dry, clean and dust free.

b) Sealer coat shall be followed with the application of epoxy phenolic coating (solid by volume minimum 63%) of minimum 400 micron DFT. This coat shall be applied after an interval of minimum 24 hours (from the application of primer coat) by airless spray technique.

5.05.01.24 Coating on RCC water retaining structures (drinking water)

Internal surfaces of RCC water retaining structures shall be provided with minimum 400 micron Food grade epoxy coating complying to FDA Title 21, Part 175.300. Surface to be coated shall be absolutely dry, clean and dust free.

5.05.01.25 **Architectural Concepts and Finishing Schedule**

Architectural concepts and finishing schedule shall be as specified elsewhere in architectural specification.

5.05.02 **Acid / Alkali Resistant Treatment:**

Acid / alkali resistant lining treatment shall be provided in different areas as follows:

Neutralization Pit: The walls shall be provided with one coat of bitumen primer, followed by 18 mm thick bitumastic layer, 115 mm thick A.R. bricks, 6 mm thick under bed of potassium silicate mortar, pointing the joints of bricks with acid / alkali resistant epoxy / furane mortar upto a depth of 20 mm and bitumastic end sealing. Suitable pilasters shall be provided with A.R. bricks at regular intervals depending upon the height of lining, as per the specification.

The floor of neutralization pit shall be provided with acid / alkali resistant lining treatment as given in the above para, except that the 115 mm thick A.R.bricks layer shall be replaced by 75 mm thick A.R. tile layer and pilasters shall be omitted.

The ceiling of neutralization pit shall be provided with one coat of epoxy primer followed by 2 coats of epoxy paint (150 micron).

Acid / Alkali storage area / projections above the floor, pedestals projecting from the floor / saddles. The floor shall be provided with one coat of bitumen primer followed by 12 mm thick bitumastic layer, 20 mm thick A.R. tiles, 6 mm thick under - bed by potassium silicate mortar, 6mm thick pointing of joints of tiles with acid / alkali resistant epoxy / furane mortar up to a depth of 20 mm and bitumastic end sealing. Dado of 1.0M high with above treatment shall also be provided if applicable in case of walls nearby.

Alum/Lime Storage area and first floor of Chemical House : One coat of bitumen primer followed by 12mm thick bitumastic layer, 20 mm thick A.R. tiles, 6 mm thick underbed of potassium silicate mortar, 6mm thick pointing of joints of tiles with acid /alkali resistant epoxy /furane mortar up to a depth of 20 mm and bitumastic end sealing.

Alum solution preparation tank: The wall shall be provided with one coat of bitumen primer followed by 12 mm thick bitumastic layer, 75 mm thick A.R. tiles, 6 mm thick underbed by potassium silicate mortar, pointing of joints of tiles with acid / alkali resistant epoxy / furane mortar upto a depth of 20 mm and bitumastic end sealing.

The floor shall be provided with acid / alkali resistant lining treatment as given in the above para except that the 75 mm thick A.R. tile layer shall be replaced by 12 mm thick A.R. tile layer.

Basket of Alum Solution Preparation tank: 5mm thick epoxy lining over a coat of epoxy primer.

Curved surfaces of saddles shall have minimum 12 MM thick bitumastic layer to support the vessel / tanks.

Effluent Drains: Acid Resistant lining treatment indicated for the storage area shall be provided on the bed as well as walls of the drains with 38 MM AR tiles. The underside of the pre-cast slab cover shall be applied with one coat of epoxy primer and two coats of epoxy coating, total DFT 150 microns.

Lime tank: Two coats of bitumen paint conforming to IS : 9862, with total DFT 150 microns.

Guarantee

The Contractor shall give a guarantee for satisfactory functioning of the lining for a period of 36 months from the date of completion of the work or date of handing over the site to the Engineer, whichever is later.

The Contractor shall replace / rectify defects is any, observed in the lining to the satisfaction of the Engineer without any extra cost during this period.

5.05.03 Foundation of overground steel circular water storage tanks

5.05.03.01 General Requirements

The tank foundation shall be as per IS:803 and as specified in relevant clause of foundation chapter.

5.05.03.02 Sub Grade Preparation

The surface of natural soil shall be thoroughly compacted by rolling or other means, as directed by Engineer, to obtain 95% of max. laboratory dry density for the soil, as per IS:2720 (Part-VII).

5.05.03.03 Anti Corrosive Layer

Anti-corrosive layer shall consists of 75mm thick Bitumen aggregate mix on top and compacted soil fill below. The bitumen-aggregate mix shall consists of compacted crushed stone , screenings, fine gravel, clean coarse sand (river sand) mixed in hot asphalt (8 to 10 percent by volume) and rolled or compacted.

~~Sand shall be thoroughly mixed with it in a mixing drum to obtain uniform mixture and shall~~ be laid over the compacted surface, laid in line, grade and levels and as directed by the Engineer. Bitumen shall not be heated beyond the temperature limits given above.

The premix carpet shall be laid in two layers of 3 cm and 2 cm respectively. After compacting and laying the first layer of 3cm, a tack coat of hot bitumen at the rate of 1 Kg. per Sq.m. shall be uniformly applied to the surface, by means of Sprayer and the Second layer of 2cm thick shall be laid, tamped and compacted to the satisfaction of the Engineer.

Sand shall be spread on the final surface at the rate of 0.5 Cu. m per 100Sq.m.

5.05.03.04 Premix Deleted

Materials

Sand

Sand shall be clean, dry, coarse, hard angular, free from coatings of clay, dust and mix of vegetable and organic matters and shall conform to IS 383 (Grade -III).

Stone Chippings

Stone chippings shall be hard black trap or granite or approved locally available stone and shall conform to IS 383. The grading shall be of normally 12mm down size and 6mm down size, in the ratio of 3:2 respectively.

Bitumen

Bitumen required for the work shall be 80/100 grade or its equivalent quality.

Laying

Areas on which the premix is to be laid shall be thoroughly cleaned of all dust and loose materials. On the cleaned surface, a tack coat at the rate of 1.0 Kg. per Sq.M. of hot Bitumen shall be uniformly applied by Sprayers. The applied Binder shall be evenly brushed.

The Binder bitumen 80/100 shall be heated to the temperature of about 190^0 C with 3% kerosene, if required and mixed with stone chippings of size, as mentioned above, at the rate of 400 KG, with Six (6) Cu. M. of stone chips, for 100 Sq.M. of surface. The total mixed quantity, as mentioned above, is the quantity required for the total 50mm thick for 100 Sq. m. of area. Mixing shall continue until the aggregate is well coated.

5.06 **Switchyard Civil Works**

5.06.01 **Civil works for GIS and AIS includes:**

a. Towers, girders, lightning masts (if provided) and equipment supporting structures including proto type assembly etc.,

b. Foundations and supporting pedestals for towers, lightning masts (if provided), equipment supporting structures etc.,

c. 765kV GIS building, 132kV GIS building and Switchyard control room building.

d. Foundations for transformers and reactors including oil pit, stone filling, laying and fixing of rails for movement of Transformers / reactors, rail track, jacking pad and fire walls as required, arrangement for cabling etc. all complete

e. Earthing mat, single lane roads and R.C.C. drains in switchyard area including road/drain/trench crossings etc.,

f. All necessary embedments, inserts, supporting structures & supporting members as required etc.

g. Cable trenches in switchyard and inside GIS building/Control room building including civil works for panel fixing etc.

5.06.02 **Design Criteria**

5.06.02.01 Gantry structure, which consists of open web towers connected by girders, shall be made of structural steel conforming to IS 2062 and duly galvanized conforming to IS: 2629 and IS 4759. All joints shall be bolted connections. All bolts for connections shall be of 16mm dia conforming to IS 12427 and of property class 5.6 as per IS 1367 (Part 3). Nuts shall conform to IS 1363 (Part 3) of property class 5. Foundation bolts shall conform to IS 5624 and property class shall be 4.6 as per IS 1367 (Part-3). Butt splice shall be used for splicing the main members and splice shall be located away from the node point. IS 802 “Code of practice for use of structural steel in overhead transmission line towers” shall be followed for design of structures. Height & type of towers shall be established based on electrical requirements. A provision of ± 30 degree angle of deviation of line in horizontal plane and ± 20 degree deviation in vertical plane is considered and the resulting worst combination of forces shall be considered for design. For all outgoing and incoming feeders, the conductor span shall be taken as 200m for design purpose.

The analysis of towers and gantries shall be carried out with combined model of critical configurations of towers and gantries using any established structural analysis software like STAAD Pro. etc.

5.06.02.02 Switchyard structures shall be designed for the worst combination of following loads:

1) Dead loads (load of wires/conductors, insulator, electrical equipment and structural members),

2) Live loads,

3) Wind loads

a. Switchyard gantries, towers, equipment supporting structures and lightning mast shall be designed as per IS 802. The wind load calculations shall be made as per IS: 802 except the parameters basic wind speed (Vb) and terrain category as stipulated in “Criteria for wind resistant design of structures and equipment”.

b. All other structures shall be designed as per IS 456 / IS 800. The wind load calculations to be made as per IS: 875 shall be with the parameters as stipulated in “Criteria for wind resistant design of structures and equipment”.

4) Seismic loads,

5) Loads due to deviation of conductor (gantries shall be checked for ± 30 deg. deviation in

horizontal plane and ± 20 degree deviation in vertical plane),

6) Loads due to unbalanced tension in conductor/wire,

7) Torsional load due to unbalanced vertical and horizontal forces,

8) Erection loads,

9) Short circuit forces including snap in case of bundled conductors, etc.

Note:

i. The occurrence of earthquake and maximum wind pressure is unlikely to take place at the same time. The structure shall be designed for either of the two. However, temperature stresses can be ignored, as these towers are freestanding structure in open space.

ii. Short Circuit forces and Wind pressure shall be considered to act together for design of switchyard structures

iii. Direction of wind shall be assumed such as to produce maximum stresses in any member for the combination of wind load with conductor tensions. The wind acting perpendicular and parallel to bus conductor and shield wire shall be considered separately.

iv. The conductor tension shall be assumed as acting on only one side of the gantry for the analysis and design of switchyard gantries.

v. The distance between terminal and dead end gantry shall be taken as 200 meters.

5.06.02.03 **Factor of safety:**

The factor of safety for the design of members shall be considered as 2.0 for normal condition and broken wire condition, 1.5 for combined short circuit and broken wire condition. Foundation shall be designed for a factor of safety of 2.2 for normal and broken wire condition and 1.65 for combined short circuit and broken wire condition. For calculating restoring moment, weight of earth on footing pad without any inclination on sides shall only be considered.

5.06.02.04 **Design consideration for switchyard equipment support:**

The supporting structure for B.P.I., LA, CVT & Isolator equipments shall be comprised of GI (ERW) pipe of grade YST:210 or of higher grade conforming to IS: 1161 & shall be designed as per IS 806 “Code of Practice for use of steel tubes in general building construction”.

Minimum diameter of the pipe type support for 765kV structure shall be 300NB, for 400kV structure shall be 250NB, for 220kV and 132kV structures shall be 200NB and that for 66kV and 33kV shall be 150 NB.The supporting structure for CT, CSE & Wave Trap equipment shall be comprised of lattice structural steel conforming to IS 2062 and shall be designed as per IS: 802.

Common raft foundation shall be provided for each pole of isolator.

5.06.02.05 **Special design consideration for lightning Mast:**

Diagonal wind condition shall be considered for lightning masts. Diagonal wind shall be taken as 1.2 times the wind calculated on Longitudinal/Transverse side. Lightning mast shall be provided with minimum two nos. of platforms as per requirement and an\ ladder for climbing purpose shall be provided up to platform at top level. Top of platform shall have grating, railing and toe guard plates. The minimum width of platform shall be 900mm. Live load of 300kg/m2 above platforms shall be considered for design of Lightning Mast.

5.06.02.06 **Design Criteria for structures not covered under Cl. 5.06.02.01 to Cl. 5.06.02.05**

The Switchyard Control Room building shall have RCC framed super structure with one brick thick wall cladding on exterior face. The Control room building shall consist of

	rooms/facilities/ equipment/ monorail as per system requirement. An open space of one meter width (minimum) shall be provided on the periphery of the panel rows and equipment to allow easy operator movement and access for maintenance purposes. The design of RCC structures shall generally be carried out using limit state method of design as per IS 456. The minimum grade of concrete shall be of RCC M25 as per IS 456. The GIS building shall be a Steel framed superstructure with external wall cladding and roof sheeting of 0.6mm bare metal thickness. However, brick cladding shall be provided up to a height of 900mm from Finished Floor Level (FFL). GIS building shall consist of rooms/facilities/equipment/EOT crane as per system requirement. Design of steel superstructure shall be carried out by IS:800 and other relevant IS standards..
5.06.03	The architectural features including roof water proofing, rain water down comers and RCC parapet walls etc. shall be as specified elsewhere in the specifications.
5.06.04	The fabrication and erection of the switchyard works shall be carried out generally in accordance with IS 802 and IS 800. All materials shall be completely shop fabricated and galvanised.
5.06.05	All structural steel members including stub members, bolts, nuts, spring washers, etc., shall be hot dip galvanised after fabrication. Minimum section thickness should not be less than 4 mm. Weight of zinc coating shall be at least 0.610 kg/m2 and foundation bolts shall have heavier zinc coating at least 0.80 kg/m2.
5.06.06	**Cable Trenches** Cable trenches shall be provided for routing of cables as required and shall be of adequate size. The trenches located within switchyard shall project at least 300 mm above the finished formation level so that no storm water shall enter into the trench. The bottom of trench shall be provided with a longitudinal slope of 1:500. The downstream end of cable trenches shall be connected to sump pits. The precast covers shall not be more than 300mm in width and ~~shall not be more than 65 kg~~. Lifting hooks shall be provided in the precast covers. Trenches shall be given a slope of 1:250 in the direction perpendicular to the run of the trenches. Angle of size 50x50x6 mm (minimum) with lugs shall be provided in the edges of RCC cable trenches and any other place where breakage of corners of concrete is expected. All cable trenches shall be provided with suitable insert plates for fixing support angles of cable trays. All internal cable trenches shall have minimum 6mm thick (o/p) chequered plate covers while external cable trenches shall have pre - cast RCC covers. However, the portion of the cable trench behind and sides of control panel / MCC shall be provided with suitable chequered plate covers as directed by the Engineer. Cable trenches inside switchyard, having depth more than 500mm, shall have wall thickness of minimum 150mm with two layer reinforcement.
5.06.07	**Stone Filling:** Stone filling shall be provided as specified elsewhere in the specifications. Each layer shall be compacted by using 1/2 tonne roller with 4-5 passes and suitable water sprinkling. Before laying the stone fill, the top layer of the soil shall be treated for anti-weed considering the types of weeds found in the vicinity. The anti-weed/soil sterlization chemical shall be procured from reputed manufacturer. The Bidder shall submit necessary details pertaining to the types of weeds found in the vicinity, anti-weed/soil sterlization such as manufacturer's name, their specification, test certificate, etc., for Employer's approval. Any modification, if required in the proposed anti-weed treatment chemicals, shall have to be done by the Bidder at no extra cost to the Employer. The Bidder shall be required to furnish a performance guarantee of three years for the anti-weed treatment. This guarantee shall commence from the date of completion of work or date of handing over, whichever is later.
5.06.08	**Transformer/reactor foundations** Foundations of transformers/reactors shall be designed for seismic and wind loads. Block foundations shall be provided for the main transformer block.

The oil soak pit, if provided, shall be filled with gravel of size 40mm. The volume of the soak pit shall be sufficient to store complete oil of the transformer/reactor along with 10 minutes of fire water considering only 40% of the volume as available voids between Stone-filling. However, in case a separate oil collection tank is provided for the transformer/reactor, oil soak pit of volume equivalent to one-third (1/3) the oil volume of transformer/reactor shall be provided around transformer/reactor. The oil collection tank, in such cases, shall be designed for an effective capacity of complete oil of the transformer along with 10 minutes of fire water. The oil soak pit shall also be provided with a sump at the corner to allow drainage of water/oil from the soak pit.

Arrangement for moving the transformer into place using rail cum road, jacking pads and pulling blocks including inserts, as required, shall be provided along with the transformer/reactor foundations.

RCC Firewall shall also be provided between the transformers wherever required.

300 mm thick PCC M20 encasement all around the Pylon supports inside soak pit for fire fighting system shall be provided up to top of Stone filling. Coarse aggregate filling inside the transformer oil soak pit shall be carried out only after construction/erection of Pylon supports and PCC encasement.

5.06.09 The switchyard roads, drains, fencing and gate shall be as specified elsewhere in the specification.

5.07.00 COAL HANDLING PLANT

It includes the Civil, Structural and Architectural works related mainly to the following areas (but not limited to):

5.07.01 Track Hopper, Wagon Tipplers, Underground TP's & Tunnel

Track hopper and machinery hatches shall consist of underground portion, which shall be of R. C. C., and above ground portion, which shall be of structural steel shed covered with permanently Colour coated profiled steel sheets.

A continuous slit of 2 m high from bottom shall be provided all along the length of shed (excluding machinery hatch). Structural shed shall also be provided with ventilation arrangement with louvered windows at top.

~~The structural arrangement to be adopted for the design and construction of underground portion of track hopper and machinery hatches shall be as shown in tender drawing. It~~ The structural arrangement of track hopper shall essentially consists of R. C. C. frames spaced at approx. 3.0M centers with R. C. C. wall panels on the sides and R. C. C. raft at the bottom, fixed to the frames. The top beam of the R. C. C. frame supports the rail supporting beams and the coal hopper. Minimum thickness of R. C. C. raft at bottom shall be 600 mm. Minimum thickness of RCC side walls shall be 600 mm at bottom and 300 mm at top.

No columns shall be provided inside the Machinery Hatches.

The vertical and inclined portion of coal hopper, the beams and top of coal tray in the track hopper structure as shown in the tender drawing shall be provided with 50 mm thick guniting (shotcreting). Complete inside surfaces of Wagon tippler shall also be provided with 50mm thick guniting. Details of shotcreting have been given elsewhere in this specification. Shed shall be provided over Wagon tipplers.

Expansion joints shall be provided at a maximum distance of 40m unless otherwise shown in the tender drawing. 600 mm wide water stop fabricated with 22G copper plate with bitumen board fillers and polysulphide sealing compound as specified elsewhere shall be used as expansion joint material. ~~Detailing of expansion joints shall be as per details in the tender drawing~~.

Floor shall be provided with cross slope not flatter than 1 in 50 towards side drains. Side drains shall be sloped towards sump where sump pumps as specified elsewhere, shall be provided. The slope of side drains shall not be flatter than 1 in 400. Side drains and sump shall have removable type steel grating cover. Gratings shall be galvanized to grade 610 gm/m^2.

Water proofing / Damp proofing of under ground portion of track hopper and machinery hatches, Wagon tippler, reclaim hoppers, tunnels, underground (i. e. basement) portion of transfer houses shall be done by providing the following treatments:

a. Chemical injection grouting for inner faces (details as specified elsewhere).

b. Polymer modified cementitious coating on earth side face as per the following :

(1.) On the outer surface of walls, frames and roof slabs coming in contact with earth, polymer modified cementitious coating in two layers as specified and as per manufacturer's specifications shall be provided directly on the concrete surface.

(2.) 50 mm thick P. C. C. (1 : 2 : 4 with 10 mm nominal size stone aggregates) shall be provided under the raft i.e. over the lean concrete, followed by polymer modified cementitious coating in two layers (slurry mix application) as per manufacturer's specification. 50 mm thick P. C. C. (1 : 2 : 4) with 10 mm nominal size stone aggregates shall then be laid over the polymer modified cementitious coating before laying the raft.

Track hopper shall have removable type steel grating cover. The opening size for the grating shall be 400 mm x 400 mm. Machinery hatches shall have removable steel chequered plate cover. Track hopper grating shall be built of min. 150mm x 16mm thick flats in one direction and 100mm x 12mm thick flats in other direction. No painting/galvanization shall be provided in gratings. However, two coats of red oxide primer to be provided immediately after fabrication.

Steel gratings of mesh size 350mm x320 mm(clear) for wagon tippler hopper shall be provided. The grating shall be built of min. 200mm x 32mm thick flats in main direction and min. 100mm x 28mm thick in secondary direction. The hopper and gratings shall be designed for movement of front end loader/ bulldozer over them. Bull-dozer weight shall be considered as about 35T. No painting/galvanization shall be provided in gratings.However, two coats of Red oxide Primer to be provided immediately after fabrication.

Catwalk shall be provided along the track hopper as shown in the tender drawing.

Each machinery hatch shall be provided with a pair of R. C. C. stair for providing access to the base of track hopper / machinery hatch. Both the stairs shall be interconnected at suitable height.

Plinth protection along with drains shall be provided along the Track Hopper and around machinery hatches. However, 5m wide paving shall also be provided around machinery hatches.

The track hopper, wagon tippler are deep underground structures which are subjected to direct load from the loaded wagons / loco due to the rake movement over it, in addition to

load due to coal filled hopper and lateral earth pressure. The railway loads, analysis and design of track hopper, machinery hatches, wagon tippler, transfer point and the portion of tunnel subjected to rail loads shall be as specified in design criteria. Coefficient of dynamic augmentation shall be worked out for a train speed of 30 kms per hour

Earth pressure to be considered for design shall be due to earth pressure at rest (K_o) condition only. Earth pressure due to surcharge intensity of Railway Loads (where applicable) or Uniformly Distributed Load (U. D. L) of intensity 2 T / Sq. M. whichever is critical, shall be considered in the design.

A minimum safety factor of 1.2 against uplift of track hopper, machinery hatches, wagon tippler, transfer points (underground or with basement) and tunnels, due to ground water shall be ensured during execution and after execution, considering dead weight of the structure to be 0.9 times only, ground water table at adjoining formation level and soil wedge angle of not more than 15 degrees.

Also, FOS against uplift, to be taken as 1.0, considering the dead wt. of structure and soil resting on side projections if any in the vertical plane. Inclined wedge action of soil shall not be considered in this case.

Walkway width and hand railing shall be provided as specified in the tender drawing.

Wherever, slope of tunnel exceeds 10°, R. C. C. steps shall be provided for the entire width of each walkway.

Track hopper structure shall be analyzed and designed for the worst load combinations. However, it shall be analyzed for the following load combinations also.

a. Load Combination - I

(1.) Hopper full

(2.) Maximum load from Railway Track

(3.) Earth pressure without surcharge and subsoil water pressure

(4.) Maximum load from steel columns for shed

(5.) Maximum load from paddle feeder support

(6.) Maximum load from coal tray.

b. Load Combination - II

(1.) Hopper full

(2.) Maximum load from Railway Track

(3.) Earth pressure with surcharge and subsoil water pressure

(4.) Maximum load from steel columns for shed

(5.) Maximum load from paddle feeder support

(6.) Maximum load from coal tray.

c. Load Combination - III

(1.) Hopper empty

(2.) No load on Railway Track

(3.) Earth pressure with surcharge and subsoil water pressure

(4.) No load from steel columns for shed

(5.) Dead load only from paddle feeder supporting structure

(6.) Dead load only from coal tray.

5.07.02 Overhead / Ground Conveyor Galleries and Trestles

Overhead conveyors shall be located in a suitably enclosed gallery of structural steel. The overhead gallery shall consist of two vertical latticed girders having rigid jointed portal frame at both ends. Cross beams at floor level supporting conveyor stringer beams shall be made of single rolled steel beam or single channel section (ISMB or ISMC) or plate girder. Horizontal bracings are to be provided at top & bottom plan of the gallery (latticed girders shall be braced together in plan at the top and bottom). Common end portal frame shall not be used for adjacent conveyor spans. Roof truss shall be provided at upper node points of latticed girders to form an enclosure. The maximum span of overhead gallery shall be limited to 25 meters unless higher span is required due to site conditions, which shall be subject to approval of the Engineer. The gallery should as far as possible be erected as a box section keeping all the vertical and horizontal bracing tied in proper position. The gallery should be checked for all erection stresses that are likely to develop during handling and erection and if required, temporary strengthening of gallery members during erection shall be made.

Contractor can also use tubular steel sections for roof truss of conveyor galleries only. The tubular steel section shall be of circular/ rectangular/square shape. The circular steel tube shall conform to IS 1161 and rectangular/square steel sections shall conform to IS 4923. The steel structures using tubular sections shall be designed and fabricated as per IS 806 - "Code of Practice for use of steel tubes in general building construction." and EN 1993-1-8:2005.

Seal plates under the conveyor galleries shall be provided in such a way that complete gallery bottom shall form a leak proof floor.

The ground conveyors shall be located in suitably enclosed gallery of structural steel consisting of rigid portal frames spaced at regular intervals and suitably braced. Plinth protection along with drains shall be routed along the ground conveyors.

For double stream conveyor gallery, two side and one central walkway of minimum width 800 mm and 1100 mm respectively shall be provided. The minimum width of two side walkways for single stream conveyor gallery (except tripper conveyor) shall be 800 mm and 1100 mm respectively. For tripper conveyor, the width of walkways shall be as per functional requirement. Both sides of central and side walkways shall be provided with pipe handrails all along the conveyor gallery. Hand railing should not be supported on conveyor supporting stringers. The walkways shall be chequered plate construction with anti - skid arrangement. The anti - skid arrangement will consist of welding of 10 mm square steel bars at a maximum

spacing of 500 mm along the length of the gallery. Where the slope of walkway is more than 10°, chequered plate steps with nosing and toe guard shall be provided. The floor of conveyor gallery all along the gallery length, shall be provided with minimum 12 gauge thick seal plates and other drainage arrangements as specified elsewhere

Conveyor gallery shall have permanently colour coated steel sheet covers on roof and both sides. However in roof, a panel of minimum 1.5 m x 1.5 m area at about 6.0 m center shall be provided with translucent sheets of polycarbonate material for natural lighting. A continuous slit opening of 500 mm shall be provided on both sides just below the roof sheeting. Adequate provision of windows shall be kept on both sides of conveyor gallery as appended in Mechanical Section (Belt conveyor system). Windows shall be provided with wire mesh as specified elsewhere in this specification.

Cross - over with chequered plate platform and ladder for crossing over the conveyors shall be provided at approximately every 100 M intervals of conveyor. Crossover shall preferably be located over four-legged rigid trestle location.

For railway tracks passing below overhead conveyor gallery and along conveyors, the railway clearances both underground as well as over ground shall have to be adhered to for design, execution and erection of foundations, trestles, galleries etc., so that movement of locomotives and wagons is not hampered in any way during execution and afterwards. However at the location where the overhead conveyor gallery crosses road / rail line, minimum clearance of 8.0m above the road crest / rail top shall be provided.

For calculation of coal load on moving conveyor, a multiplication factor 1.6 shall be used to take care of inertia force, casual over burden and impact factor etc.

Thus coal load per unit length of each moving conveyor shall be

$$1.6 \times \frac{\text{Rated Capacity of Conveyor system}}{\text{Conveyor Belt Speed}} \times \frac{1100}{800}$$

It should be noted that for structural design, unit weight of coal shall be assumed as 1100 Kgs. / Cu. M. instead of 800 Kgs. / Cu. M. considered for system sizing purpose.

Conveyor Gallery structure shall be designed considering both conveyors operating simultaneously.

Conveyor gallery and supporting trestles located between transfer houses / buildings shall be arranged in any one of the following ways.

a) All gallery supporting trestles shall be four legged type only. One end of each gallery span shall be hinged to the supporting trestle and the other end shall be slide type. Slide type support shall be with P. T. F. E. bearings to allow both rotation & longitudinal movements.

OR

b) In between transfer houses / buildings, four legged trestles shall be placed at a maximum interval of 90 metre. The arrangement shall be such so as to ensure that force in the longitudinal direction (i. e. along the conveyor length) of conveyor gallery of length

not more than 90 m is transferred to any four legged trestle. In the space between each successive four legged trestles, two legged trestles shall be provided at regular intervals. The end supports resting on the four-legged trestle can have either ends hinged or one hinge and the other on slide type depending on the arrangements. Slide type support shall be with P. T. F. E. bearings to allow both rotation & longitudinal movements.

End of conveyor gallery which will be supported over transfer house, shall be so detailed that only vertical reaction is transferred from conveyor gallery and no horizontal force in longitudinal direction is transferred from conveyor gallery to transfer house structure and vice - versa.

For trestles and trestle foundations for conveyor galleries located adjacent to existing structures, over ground and underground facilities, location and details of these trestles and foundations shall have to be decided such that there is no interference both underground as well as over ground with existing structures and facilities. Trestle columns / ground conveyor portal column base shall be kept 300 mm higher than the existing ground level.

5.07.03 **Transfer Houses**

The over ground portion of all transfer houses shall be framed structure of structural steel work with permanently colour coated profiled steel sheet side cladding (from lowest working floor level till top) and R. C. C. floors comprising of RCC slab over profiled metal deck sheets (to be used as permanent shuttering) over structural beams. Shear anchor studs shall be provided through metal deck at regular interval on all top flange/flange plate of structural beams. However the lower portion of side cladding for a minimum height of 0.9 m above the finished floor level shall be one brick thick wall plastered on both side. In some areas like MCC floors etc., one brick thick wall cladding shall be provided. Brick wall cladding shall be supported on encased wall beams and suitably anchored to adjoining columns and beams. ~~In all transfer points, contractor shall have option to use Tubular steel sections for bracings only.~~ Vertical bracings shall be provided only on four sides along the periphery. Grade slab with 0.9m height one brick thick wall plastered on both side at periphery shall be provided for all transfer houses.

Adequate steel doors and windows for proper natural lighting and ventilation shall be provided. In addition to steel windows, panels of suitable size to suit the architectural treatment and made of translucent sheets of polycarbonate material shall also be provided on the side cladding for natural lighting.

~~Roof shall be provided with troughed profile permanently colour coated sheet on outside and plain permanently colour coated sheet on inside with 50mm thick mineral wool insulation in between the two sheets. Proper gradient shall be provided for quick drainage of rain water. Mineral wool insulation (as per IS: 8183)having a density of 32 kg/cum for glass wool or 48 kg/cum for rock wool, bound in polythene bags shall be used, with or without framed strips 25x3mm (min.) at maximum 300mm c/c to hold the insulation between the runners, keeping in position with galvanized hexagonal wire netting of 0.3mm wire dia. & 19mm mesh size as per manufacturer's recommendations.~~

The roof of Transfer houses shall be provided with per-fabricated insulated metal sandwich panels. Pr-Fabricated Insulated Metal Sandwich Panel for Roofing shall be laid to specified slope. Composition of Insulated Metal Sandwich Panels shall be as described in the Technical Specification. Adequate slope shall be provided for quick drainage of rain water.

5.07.04 **Crusher House**

The crusher house shall be framed structure of structural steel work with permanently colour coated profiled steel sheet side cladding. However, panels of suitable size to suit the architectural treatment and made of translucent sheets of polycarbonate material shall also be provided on the side cladding for natural lighting. The lower portion of side cladding for a height of minimum 0.9m above the finished floor level shall be of one brick thick wall plastered on both faces. Floors shall be of R. C. C. comprising of RCC slab over profiled metal deck sheets (to be used as permanent shuttering) over structural beams. Shear anchor studs shall be provided through metal deck at regular interval on all top flange/flange plate of structural beams. Within this building, cubicles for resting room of operators shall be constructed with one brick thick brickwork having both sides plastered and roof slab. Adequate steel doors and windows for natural lighting and ventilation shall be provided. ~~In Crusher house, contractor shall have option to use Tubular steel sections for bracings only.Vertical bracings shall be provided only on four sides along the periphery.~~

The roof of Transfer houses shall be provided with pre-fabricated insulated metal sandwich panels. Pre-Fabricated Insulated Metal Sandwich Panel for Roofing shall be laid to specified slope. Composition of Insulated Metal Sandwich Panels shall be as described elsewhere in the Technical Specification. Adequate slope shall be provided for quick drainage of rain water

~~Roof shall be provided with troughed profile permanently colour coated sheet on outside and plain permanently colour coated sheet on inside with 50mm thick mineral wool insulation in between the two sheets. A slope of 1 in 5 shall be provided for quick drainage of rain water. Mineral wool insulation (as per IS: 8183)having a density of 32 kg/cum for glass wool or 48 kg/cum for rock wool, bound in polythene bags shall be used, with or without framed strips 25x3mm (min.) at maximum 300mm c/c to hold the insulation between the runners, keeping in position with galvanized hexagonal wire netting of 0.3mm wire dia. & 19mm mesh size as per manufacturer's recommendations.~~

Ring Granulator type Crushers shall be supported on R. C. C. deck, which in turn will rest on suitable vibration isolation system consisting of springs and dampers. This R. C. C. deck shall be isolated from the floor. However, the vibration isolation system consisting of springs and dampers may rest on main building framework. Detailed specification of vibration isolation system including the unbalanced force (due to ring granulator), frequency and amplitude criteria and other design requirements are appended elsewhere in this specification.

5.07.05 **Stacker-Reclaimer/Reclaimer Foundation**

Stacker-Reclaimer/Reclaimer foundation shall be in R.C.C. and shall be designed as a continuous wall or R.C.C. framed structures (in longitudinal & transverse direction). Lateral tie beams between two rail supporting elements shall be provided at a regular interval of approx. 3.0 m center. The foundation shall be designed for the most critical combination of loads as furnished by the equipment supplier. R.C.C retaining wall on both sides of the S/R foundation shall be provided as shown in the tender drawing.

The portion between the two rails shall be paved in concrete as per specification for grade slab of ground level specified elsewhere. However no metallic hardener finish over R. C. C. slabs is to be provided. Drains shall be provided along the rails for drainage of rain / dust suppression / floor washing water. Drains shall be routed on both sides of the foundation along the rail as shown in Tender Drawing. Drains shall be connected to the network drainage system for finally discharge into coal settling tank. RCC drains shall be provided in Coal stockyard area with precast RCC covers.

5.07.06 **Control building, M. C. C. Buildings**

or RCC

For steel framed building roof/ floor shall comprise

These shall be steel framed building with R. C. C. roof and floor ~~comprising~~ of RCC slab over profiled metal deck sheets(to be used as permanent shuttering) over structural beams. Shear anchor studs shall be provided through metal deck at regular interval on all top flange/flange plate of structural beams. Cladding shall be of brickwork/concrete blockwork with plastering on both sides. Bidder has also the option to supply and construct pre-engineered buildings Roof shall be provided with roof water proofing treatment, as specified elsewhere in the Technical specification. Suitable arrangement shall be provided so as to prevent ingress of water into the cable trenches inside the building from cable entry locations.

All air - conditioned areas, shall be provided with the suspended permanently colour coated aluminium false ceiling system (details specified elsewhere) with under deck insulation.

Adequate aluminium doors and windows shall be provided for natural lighting, ventilation and view. All windows in air conditioned rooms shall have hermetically sealed double glazing.

5.07.07 **Pump Houses**

These shall be framed structure of structural steel work with permanently colour coated profiled steel sheet roof, grade slab and RCC foundations etc.. Roof shall be provided with troughed profile permanently colour coated sheet with slope of 1 in 5 for quick drainage of rain water. Brick wall (1m height above FFL) shall be provided all around the periphery of pump houses.

5.07.08 **Pent House**

These shall be of R. C. C. framed structures with columns, beams, slabs and foundations etc. Cladding shall be of brickwork with plastering on both sides. Roof shall be provided with roof water proofing treatment as specified elsewhere. Adequate nos. of steel doors and windows shall be provided for natural lighting and ventilation.

5.07.09 **Toilets**

Toilet with potable water line facilities shall be provided in each of the following locations:

a. Crusher House (Ground Floor)

b. In all M. C. C./ Control Room building

Each unit shall have brick enclosure, and the following fittings.

i)	Squatting type, white, vitreous china Orissa pattern, W.C. pan with flush valve and all requisite fittings. In addition, for control building one no. wall mounted glazed vitreous china European water closet with flushing valve shall be provided.	1 No.

	ii)	White glazed vitreous china flat back lipped urinal with photovoltaic control system for flushing and all requisite fittings	1 No.
	iii)	Wash Basin 630 mm x 450 mm mounted over granite beveled edge counter fitted with photovoltaic control system for water controls, bottle trap with two taps and all requisite items	1 No.
	iv)	Mirror 600 mm x 450 mm x 5.5 mm thick withbevelled edges (Superior sheet glass)	1 No.
	v)	C.P. Brass Towel Rod 600 x 20 mm	1 No.
	vi)	Liquid Soap Container	2 Nos.
	vii)	Washing Tap (CP Brass)	1 No.
	viii)	Overhead Polyethylene water tank (min. 500 litres capacity)	1 No.
	ix)	Suitable provision for installation of water coolers.	
	x)	For control room buildings, pantry with granite top counter& stainless steel sink.	1 No.

5.07.10 **Staircases**

and mumty of staircase shall be accessible through cage ladder

multistoried

All floors of transfer houses/crusher house and roof/floors of all MCC/Control room buildings shall be accessible through staircase. Cage ladders (min. 450mm wide) shall be provided for access to roof of penthouses, MCC/control room (with only ground floor)

All stairs of overground portion of transfer houses & crusher house shall be of steel (minimum 1200mm wide)and maximum rise should not be more than 180 mm and minimum tread width 250 mm. Stringers shall be of rolled steel channel(minimum ISMC 250)and tread shall be of electroforged steel gratings. Stairs shall be provided with 32 mm dia nominal bore medium duty M. S. pipe hand rail.

Handrails (for staircases, around openings, in walkways etc.) shall be of standard weight steel pipe of flush welded constructions, ground smooth using 32 mm nominal bore medium class pipe provided with double rail, top rail about 1.0 metre above platform level and pipe posts spaced not more than 1.5 metres apart. Angle handrail post may be provided when specifically called for in drawings approved by Engineering. Toe guard of size 100mm x 6mm shall be provided along the railing for all steel platforms/landings and RCC staircases.

Smooth uniform curves and bends shall be provided at stair returns and also where so ever required. Posts connected to curb plates shall have a neat closure at the bottom and a 6 mm thick plate neatly welded to posts for attachment to curb plate. All necessary fittings including inner dowels at splices, brackets, belts, bends, flanges and chains, where required shall be plugged and welded. A minimum radius of 3 times the pipe diameter shall be provided at all points of direction changes in the handrail.

Treads and landing shall be suitable for the prescribed loading. The maximum width of

openings in gratings shall not exceed 40 mm. The minimum size of main bars shall be 25 x 6 mm and cross bar shall be 6mm. The usual span of grating will not generally exceed 1.5 meters. Stair case gratings shall be galvanized to grade 610g/m2.

Out side stairs to transfer points shall be open type. However sheeting shall be provided at the top.

Stairs of MCC/control room, Wagon tippler and underground TP's shall be of R. C. C. construction. The minimum width of stairs for MCC/Control room, Wagon Tippler, Track hopper, Undeground TP's shall be 1200mm. Maximum rise should not be more than 180 mm and minimum tread with 250 mm. Minimum 50 x 50 x 6 mm size angles with lugs shall be provided as edge protection for treads of stairs in wagon tippler/underground TP's.

Numbers and arrangement (including enclosures etc.) of stair cases shall be such as to meet the fire safety requirement as per guide lines of statutory regulatory bodies.

5.07.11 **Trenches**

All trenches for cables or any other underground facility as detailed out elsewhere shall be of R. C. C. Cable trenches shall be provided with pre - cast R. C. C. covers / chequered plate cover. Cable trenches as well as pre - cast covers shall be provided with edge protection angles and lifting hooks. All embedments / block outs as required and specified elsewhere in these specifications shall be provided. Trench pre - cast cover weight shall not be more than 65 Kgs. At road crossings & entry locations, trench covers designed for 10 T wheel load at centre shall be provided. Pre - cast covers shall be designed for central point load of 75 Kgs. R. C. C. cable trenches shall be filled with sand after erection of cables, up to top level and covered with pre - cast R. C. C. covers. For cable trenches outside buildings, top level shall be 200 mm above G. L and sand filling shall be overlaid with 50 thk. PCC.

Minimum 50 x 50 x 6 mm size angles with lugs shall be provided as edge protection all around cut outs / openings in floor slabs, edges of drains supporting grating/precast RCC covers, edges of R. C. C. trenches supporting pre - cast covers, supported edges of pre - cast cover.

5.07.12 **Drainage & Water Supply Works**

5.07.12.01 Drainage System:-

The drainage arrangements shall be so planned so as to ensure quick disposal of drainage water without stagnation and / or overflow. It is envisaged to clean the conveyor galleries, transfer points, crusher building, penthouse etc. with water periodically.

Minimum 4 nos. down comers shall be provided in each transfer house / crusher house. In case of conveyor galleries, the down comer shall be provided at every trestle location.

Drainage of the complete coal stock pile, area around stacker reclaimer rails etc. shall be discharged into the coal slurry settling pond.

For Conveyors in Main plant area each down comer shall lead the water / coal slurry to RCC pit (of 2 Cu.M capacity) to allow settling of coal. The water from the pit shall overflow into R.C.C drain, which will lead the discharge finally into t effluent discharge system (Plant drain network) ~~road.~~

For Conveyors in stock pile area, each down comer shall lead the water / coal slurry to RCC pit (of 2 Cu.M capacity) to allow settling of coal. The water from the pit shall overflow into R.C.C drain, which will lead the discharge finally to the coal settling pond.

For Crusher House, Pent Houses & TP's in stock pile area, each down comer shall lead the water / coal slurry into the peripheral drains (**RCC** drains with steel gratings provided around the building) which will lead the water / coal slurry to water / coal slurry to RCC pit (of 2 Cu. M capacity) to allow settling of coal. The water from the pit shall overflow into R.C.C drain, which will lead the discharge finally into plant drain network.

For TP's in Main plant area, each down comer shall lead the water / coal slurry into the peripheral drains (**RCC** drains with steel gratings provided around the building) which will lead the water / coal slurry to RCC drain and finally into into plant drain network. ~~nearby road~~.

For wagon tippler complex and track hopper peripheral drains (RCC drains with steel gratings provided around the building) shall lead the water / coal slurry to a local RCC pit (of 2 Cu. M. capacity) near each facility to allow settling of coal. The water from the pit shall overflow into R.C.C drain, which will lead the discharge finally to the coal settling pond.

In case of Control rooms and M. C. C. buildings, Pump houses, etc, water / coal slurry coming from down comers shall discharge into peripheral drains (**RCC** drains with steel gratings provided around the building) which will lead the water / coal slurry into R.C.C drain, which will lead the discharge finally into trunk drain routed alongside the nearby road/ coal settling pond.drain, which will lead the discharge finally to the coal settling pond./ drain network.

Suitable kick plates/Curb beams shall be provided around the floor openings, stair case landings, in the transfer points, crusher house and other buildings.

Contractor's scope shall also include construction of necessary culverts under the rail lines / roads as per railway / I. R. C. standards and approval of Railway culverts from concern Railway authorities.

5.07.12.02 **Internal and external water supply, drainage etc.:-**

The scope for potable water supply includes all distribution systems, tanks, pipes, fittings etc. as required and as described here or elsewhere in these specifications.

The scope for service water supply and dust control water supply shall be as described elsewhere in these specifications.

For water supply, medium class galvanized mild steel pipes conforming to IS: 1239 shall be used.

The scope for drainage of surface water shall include design, layout and construction of drains for and from buildings and drains required for coal stockyard area, drainage up to main coal slurry settling tank including connection with the tank. Drainage system shall be designed for maximum intensity of rainfall as per area drainage study considering min. 60 % runoff coefficient with no retention time. All buildings (including transfer houses and crusher house) shall be provided with RCC drains of minimum size of 300 mm width and 300 mm depth all around the periphery. All open drains shall have removable steel grating designed for loads as specified under loading clause. Minimum size of main bar of grating (Galvanised to 610 gm/m^2) shall be 12 mm x 3mm and cross bars 6mm. At all entry or road/rail crossing point's RCC box/pipe culvert shall be provided. The opening size of grating shall not be more than 90 mm x 35 mm. All drains as well as pre - cast covers shall be provided with edge protection angles and lifting hooks.

However, drains in coal stockyard area shall have pre cast R. C. C. covers. RCC pre - cast cover weight shall not be more than 65 Kgs. RCC pre-cast covers near entry or at road crossings shall be designed for 10 T wheel load at centre. RCC pre - cast covers shall be designed for central point load of 75 Kgs.

The scope for foul water from toilets shall include layout and laying of sewers up to the main sewer line for sewerage system upto Sewerage Treatment Plant (included in Bidder's scope) together with all fittings and fixtures and inclusive of ancillary works such as connections, manholes and inspection chambers within the building and from the building to the main sewer line.

For rain water down comer and those to be used for conveying water / coal slurry generated from cleaning of walkway/floors, Galvanised MS pipes conforming to IS: 1239 (for 150 mm NB Medium grade pipes) with welded joints shall be used for MCC buildings, penthouse, control rooms and Galvanised steel ERW pipes (273mm OD, 4mm thk) of steel grade Fe330 conforming to IS: 3589 with welded joints shall be used for all TP's, Crusher house, and Conveyor galleries.

Galvanising shall be as per IS: 4736. The minimum mass of zinc coating shall not be less than 360 gms/sq.m. as per IS:6745. The zinc coating shall be smooth and shall be subjected to testing as per IS: 2633, for uniformity of coating. The zinc coating shall be free from all defects as per IS: 2629.

All rain water down comers shall be provided with roof drain heads and complete with shoes bends, junctions, sockets, adapters, brackets and finished with anti corrosive painting over a coat or primer.

For design of building drainage system IS: 1742 shall be followed.

For sanitary / sewerage pipes above ground, sand cast iron pipes conforming to IS : 1729 with leak proof lead joints.

For underground drain pipes, minimum class NP - 2 pipes conforming to IS: 458. At road crossings, concrete pipes of class NP 3 conforming to IS: 458 and at rail crossing R.C.C. box culvert to be provided.

For sewerage below ground stoneware pipes conforming to IS: 651 with concrete bedding and haunch.

5.07.13 Roof Details

Roof slab shall be minimum 150 mm above the top surface (crest) of the metal deck sheetthick and shall have minimum 10 dia HYSD reinforcement bars placed at 200 mm center both ways at top and bottom.

900 mm high and minimum 100 mm thick R. C. C. parapet wall shall be provided over roofs. Parapet wall shall have suitable coping. External face of parapet wall of the buildings provided with metal cladding shall also be finished with metal cladding of design and colour as per approved architectural drawings.

Junction of roof and parapet shall be provided with 150 x 150 mm size concrete fillet.

Drain level shall be provided with 45 x 45 cm size khurras having minimum thickness of 30 mm of M-15 concrete over PVC sheet of 1 m x 1m x 400 micron and finished with 12 mm 1 : 3 cement : sand plaster.

Roofs of all M. C. C./control rooms, penthouse, mumty etc., shall have roof water proofing treatment. Roof water proofing treatment shall be as follows:

1) Application of polymerised mastic over the RCC roof to achieve smooth surface as primer coat.
2) Application of high solid content liquid applied urethane based elastomeric water proofing membrane, over the primer coat, to give uniform joint less dry film thickness of minimum 1.5 mm (as per ASTM C 836 and C 898).
3) For efficient disposal of rain water, the run off gradient for the roof shall not be less than 1: 100. This gradient shall be provided by screed concrete M-15 (using 12.5 mm coarse aggregate) and / or cement mortar (1: 4) over the elastomeric water proofing membrane with 25mm thick cement mortar (1:4) topping.
4) Wearing course at top, shall consist of 25 mm thick P. C. C. (M-15) cast in panels of maximum 1.2 x 1.2 m size and reinforced with 0.56 mm diameter galvanized chicken wire mesh and sealing of joints using sealing compound / elastomeric water proofing membrane. Pathways for handling of materials and movement of personnel shall be provided with 22 mm thick chequered cement concrete tiles as per IS : 13801 for a width of 1000 mm in place of P. C. C.

Roof of transfer points and crusher house shall be provided with troughed profile permanently colour coated sheet on outside and plain permanently colour coated sheet on inside with 50mm thick mineral wool insulation in between the two sheets. A slope of 1 in 5 shall be provided for quick drainage of rain water.

5.07.14 Floors and Grade level details

The floor slabs shall be minimum 150 mm thick above the top surface (crest) of the metal deck sheetand shall have minimum 10 dia HYSD reinforcement bars placed at 200 mm center both ways at top and bottom

Floors of transfer points shall have cross slope of not flatter than 1: 80, towards the floor washing drainage outlets, for efficient drainage. For ground conveyor & crusher house slope shall be 1:100.

Chequered plates (used for platforms, walkways etc.) shall be minimum 6 mm thick o/p or as indicated on drawings. The chequered plate pattern shall be approved by Employer / Engineer. Mild steel flats/angles of suitable size shall be welded to the bottom portion of chequered plates at a designed spacing to stiffen chequered plates to restrict deflection within span/200. Chequered plates shall be fixed by staggered welding of suitable size.

Toe guard of size 100 x 6 mm shall be provided at various openings provided in floors e.g. around stair case openings, chute openings and other similar cutouts. For conveyor walkways, angle runner to act as toe guard shall be provided.

All along the periphery of R. C. C. floors (where no brick masonry walls are provided) shall be provided with one brick thick 300 mm high brick wall and 700 mm high steel hand rails all around over this brick work.

The grade slab shall consists of 275 mm thick rubble soling (63 mm downgraded hard stone aggregate as per IRC specification, watering and compaction to minimum of 90% Standard Proctor density, including filling the interstices of stone aggregates with sand), over well compacted earth, overlaid by 75 mm thick P. C. C. M-7.5 and 100 mm thick R. C. C. of grade

M-20 with minimum 8 mm dia bars placed at 200 mm C / C in either direction respectively. There will be minimum 50 mm thick metallic hardener finish over the R. C. C. slab.

All buildings (including wagon tippler complex, penthouse, MCC rooms, pump houses, transfer houses and crusher house) and ground conveyors shall be provided with 750 mm wide plinth protection all around. It consists of 50 mm thick P.C.C. M-20 grade with 12 mm maximum size aggregate over 200 mm thick stone soling using 40 mm nominal size rammed, consolidated and grouted with fine sand.

An area of 5 m width all round the wagon tippler complex around water tanks near pump house, transfer houses and crusher house shall be paved. This paving will be in addition to plinth protection. The paving construction shall be as per specifications for the grade slab at ground level. However, 50 mm thick metallic hardener finish is not required to be provided in paved area.

Plinth level of all buildings shall be kept at least 500 mm above the finished grade / formation level.

5.07.15 Fencing

Fencing with toe wall and steel gates shall be provided around the transformers. Fencing shall comprise of PVC coated GI chain link fencing of minimum 8G (including PVC coating) of mesh size 75 mm and of height 2.4 m above the toe wall. The diameter of the steel wire for chain link fence (excluding PVC coating) shall not be less than 12G. All Fence posts shall be of 75 x 75 x 6 MS angles spaced at 2.5 m c/c distance. All corner posts will have two stay posts and every tenth post will have transverse stay post. Suitable R. C. C. foundation for the post and stays shall be provided based on prevailing soil conditions. Gates shall be sturdy with locking provisions.

Toe walls of brick masonry shall be provided between fence posts all along the run of the fence with suitable foundation. Toe wall shall be minimum 200 mm above the formation level with 50 mm thick P. C. C. coping (1: 2. 4) and shall extend minimum 300 mm below the formation level. Toe wall shall be plastered on both sides and painted with two coats of cement paint of approved colour and shade. Toe wall shall be provided with weep holes at suitable spacing.

5.07.16 LOADING

For consideration of loads on structures IS 875 - 'Code of practice for structural safety of buildings' shall be followed. In addition to the dead load, live load, equipment load (including impact / vibration). Temperature loads etc. various loading conditions arising due to operation and maintenance of equipment shall be considered in the design. The structure and equipment shall also be designed for seismic loads as per the "Criteria for Earthquake Resistant Design of Structures and equipment" and the "Criteria for Wind Resistant Design of Structures and equipment". whichever is governing. Wind and seismic forces shall not be considered to act simultaneously. The following minimum live loads shall be adopted for the design of various structures. If actual expected load is more than the specified load, then actual load is to be considered.

a) Roofs — 150 Kgs. / Sq. M. for accessible roofs and 75 Kgs. / Sq. M. for non - accessible roofs. In addition to this coal dust load (Dead load) of 150 Kgs. / sq. m. on flat roofs & 75 Kgs. / sq. m. on inclined roofs shall also be considered.

	b)	R. C. C. floors	500 Kgs. / Sq. M.
	c)	Stair and balconies	500 Kgs. / Sq. M.
	d)	Toilet rooms	200 Kgs. / Sq. M.
	e)	Chequered plate floors	400 Kgs. / Sq. M.
	f)	Walkways (including walkways in conveyor/cable galleries)	300 Kgs. / Sq. M.
	g)	Conveyor galleries	In addition to the live loads, loads due to cable trays, fire fighting / service water pipes shall also be considered @ 125 Kgs. / m (minimum) on each of the longitudinal girder. Roof-truss members are to be checked for supporting fire fighting pipes/ Service water pipes. Tentative locations and diameter for pipes are shown in Tender Drawing.
	h)	Road Culverts and its allied structures including R. C. C. pipe crossing & road crossing of trenches.	For class 'AA' loading and checked for class A loading as per IRC standard.
	i)	Channels / trenches	In addition to earth pressure and water pressure, etc. additional earth pressure due to surcharge of 2T / Sq. M. shall also be considered for design.
	j)	Covers for trenches / channels	Covers for channels & trenches, shall be designed for a live load of 0.4T Sq. M. and loading as mentioned under clause in trenches, whichever is critical.
	k)	Sumps and tanks and other underground basement type structures	In addition to earth pressure with a surcharge of 2T / Sq. M. (or surcharge due to Railway loading whichever is critical for Railway load bearing structures etc.) and sub - soil water pressure etc. These are also to be designed for the following conditions : i) Water / liquid inside and no earth outside (applicable only to such structures which are liable to be filled up with water or any liquid). ii) Earth with surcharge outside and no water / liquid inside iii) For underground (basement) structures protection against buoyancy during execution and after execution shall be ensured without superimposed loadings with minimum factor of safety of 1.2 against buoyancy.

I) Unit weight of coal shall be taken as 1100 Kgs. / cum. for design purposes.

If the erection load is higher than the specified live loads on any floor or part thereof, then the erection loads are to be considered for the design.

Permissible increase in stresses of materials and bearing pressure of soil due to wind load or seismic load shall be as per relevant I. R. S. and I. S. code.

5.07.17 DESIGN CRITERIA

The loads for all railway load bearing structures and the analysis and the design of these structures (if any) shall be made strictly in accordance with the provisions of Indian Railway Bridge rules (latest edition), and Indian Railway Codes of practice (latest edition) with all amendments up to the date of opening of bids. The axle load for analysis and design shall be considered as "DFC loading (32.5t axle load)" of Heavy mineral loading as per Indian railway standard. The analysis, design and detailed drawing for tunnel, underground transfer houses, culverts etc. coming directly below the railway track shall be got approved by the contractor from the concerned railway authorities before taking up construction. All necessary payment for the above work shall be made by the bidder to the railway authority.

The design of all R. C. C. structures shall be carried out as per 'code of practice for plain and reinforced concrete for general building construction', IS 456.

The steel structures shall be designed and fabricated as per 'code of practice for use of structural steel in general building construction', IS : 800 and other relevant IS Standards. Minimum size of the angle section to be used as structural members shall be 50 X 50 X 6. Minimum weld size shall be 6 mm. The steel structures using tubular sections shall be designed and fabricated as per IS 806-"code of practice for use of steel tubes in general building construction." And EN 1993-1-8:2005. Minimum grade of steel & thickness of Tubular/Hollow sections shall be Yst 240 Mpa& 4.0mm respectively.

The building shall conform to local bye - laws, rules and regulations for industrial buildings and also B. I. S. publications, SP 32 and 41.

Slotted holes shall not be assumed to act as expansion joint for relieving of stresses and suitable bearings shall be provided at the supports.

All gallery supporting trestles shall be so proportioned that the transverse deflection of gallery due to wind / seismic load should not exceed trestle height / 1000 as stipulated in IS 11592. This deflection condition shall be strictly followed. Peak wind speed method shall be considered for checking the transverse deflection.

The crusher and transfer house structures shall be so designed that transverse deflection at places where conveyor galleries meet, should be equal to the respective transverse deflection of conveyor supporting trestles.

Stresses for all CHP structures shall be checked for the higher of the forces obtained from gust factor method and the peak wind speed method.

The permissible vertical deflection for beams supporting drive machinery shall be restricted to span / 500 and for other beams it shall be within span / 325.

Horizontal bracing system shall be provided at floor levels around the openings.

Shear force in steel columns shall be transferred to the pedestals / foundations exclusively either through foundation bolts or the shear key arrangement.

For design of liquid retaining structures, IS 3370 (Part - I to IV) (latest) shall be followed. Face of the structure in contact with liquid shall be designed as un - cracked section. For design of R. C. C. pipes for culverts, latest editions of IS 458, IS 783 should be followed.

For design of all underground structures / foundations, ground water table shall be assumed at the formation level (i. e. the adjoining ground level).

Design of Hopper walls shall be done for both Static & Dynamic flow condition using Walker's theory.

Design of masonry walls shall be made as per IS 1905.

Civil task drawing indicating various equipment loading and supporting arrangement and floor loads to be submitted along with the design calculation.

For metal roofing and side cladding, the spacing of purlins/runners shall be such that the deflection of metal sheet used is limited to span/250 under adverse loading condition.

Minimum reinforcement shall be provided at the top face of the footing, even if, no reinforcements are required as per design.

It is envisaged that the existing rail lines as shown in GLP will be operational during construction activity of WT, Track hopper, Underground TP's and associated tunnels is taken up. Providing necessary temporary supports such as girders/bridges (railway approved) and all measures to keep the rail lines in safe operating condition during construction of his works, shall be in bidder's scope. Obtaining necessary approvals from the concerned railway authorities including payment of fees, etc. for the same shall be in the scope of the bidder. If during construction of his work, the operating rail tracks get disturbed or damaged, the same shall be restored by the bidder as per the instructions of the engineer, at no extra cost to NTPC.

5.07.18 CHEMICAL INJECTION GROUTING

Minimum, 12 mm dia (NB) threaded nozzle of suitable length, shall be provided over the surface and along the construction joint line in a grid pattern at a spacing not exceeding 1.5 m c / c before concreting operation. Adequate precaution shall be taken to keep the nozzles plugged at both ends to prevent them from getting closed by concrete.

For fixing of any nozzle in set concrete suitable size hole shall be drilled, preferably by using repercussive hammer drill electrically operated, in grid pattern and grouting nozzle shall be fixed in these holes.

After the nozzles are fully set, neat cement slurry admixed with water soluble non - shrink polymer / monomer based chemical shall be injected through the net - work of nozzles with low pressure grout pumps at a pressure of about 2.0 Kgs. / cm2. Cement slurry shall be prepared by mixing cement with non-shrink polymer/monomer @ 500 gm/50 kg bag of cement and water, ensuring that Water: Cement ratio does not exceed 2 (by weight). Wetter the structure, lesser should be the water cement ratio. The property of the polymer/monomer should be such that when it is mixed with water @0.5% by weight of water, the viscosity of the resultant solution (water and polymer/monomer) should not be more than 1.2 centipoises. Plasticizing agent shall be added wherever required. The grouting shall be started at very low pressure and increased gradually to a required pressure. The grouting shall continue, till the hole refuses to take any further grout, even at an increased pressure. Applied pressure shall not be more than the designed strength of the concrete. After completion of grouting operation, the nozzles shall be sealed properly to the satisfaction of the Engineer.

5.07.19 POLYMER MODIFIED CEMENTITIOUS COATING

5.07.19.01 Materials

Modified liquid polymer blend shall be a dispersion containing 100 % acrylic based polymer solids. Polymer shall be mixed in the ratio of 1 cement: 0.5 polymer (for minimum solid content of polymer 30%).

Portland cement based dry powder.

Clean, fine specially prepared quartz sand approximately 0.6 mm size.

5.07.19.02 Mixing

The liquid polymer shall be stirred well and cement based powder shall then be added slowly to make a Slurry Mix. For preparation of Brush Topping Mix, quartz sand shall be added slowly and mixed well till a homogeneous mixture is obtained. The mix shall be used within half an hour of the preparation. Addition of quartz sand may not be necessary, in case dry power contains the same.

5.07.19.03 Properties of Coating

It must adhere to wet surface.

It should develop adequate bond strength, with the concrete surface, not less than 2 N / Sq. mm.

Co - efficient of permeability shall be about $5x10^{-10}$ Cm / Sec.

Water absorption after continuous soaking shall not be more than 1 %.

The materials shall be permeable under water vapour.

The material shall be resistant to acids and alkalies present in the soil and underground water with normal pH value between 4 and 14.

The co - efficient of thermal expansion of the material shall be close to that of concrete.

5.07.19.04 Application

The concrete surface shall be cleaned and made free from grease, oils or loosely adhered particles. The surface shall be damp without any free water. For exterior underground part, application (b) pertaining to Brush topping Mix shall be followed.

(a) For Slurry Mix

A minimum of 2 coats shall be applied on the surface. The first coat being applied, when the surface is still damp and left to harden for 4 to 6 hours. After 4 to 6 hours of the application of second coat, it shall be finished by rubbing down with a soft dry sponge. The coverage shall not be less than 1 : 1 Kgs. / m^2 in the 2 coats. A lap of 75 mm shall be provided at the joints.

The coating shall be air dried for 4 to 6 hours and, thereafter, cured for 7 days after the application of last coat.

(b) For Brush Topping Mix

This shall be applied in two coats. A primary coat of slurry mix can also be first applied on the surface as first coat. After the coating has dried up, a coat of Brush Topping Mix shall be applied over it with a push broom or any other similar brush. It shall be left in broom finished condition. The nominal thickness shall be 1.5 mm and minimum thickness shall be 1.0 mm. A lap of 75 mm shall be provided at the joints. It shall be ensured that no pinhole exists and rebrushing shall be done to cover the pinholes, if any.

The Coating shall be air dried for 4 to 6 hours and thereafter cured for 7 days after the application of last coat.

Rate of application of coating shall be established to achieve the required thickness.

5.07.20 SHOTCRETING

5.07.20.01 General Requirements

Generally, shotcreting shall be done in accordance with IS 9012.

Reinforcement for shotcreting shall be as detailed below, unless specified otherwise.

c. Reinforcement in one direction consisting of 6 mm M. S. bars at 750 mm c / c shall be connected to the lugs for fastening of the wire fabric. This shall be used in case of 50 mm or above thick shotcreting.

a. Wire fabric conforming to IS : 1566 shall be used as reinforcement and shall consist of wire, 3 mm diameter, spaced 50 mm both ways and shall be electrically cross welded. Wire fabric shall be securely tied to 6 mm bars for 50 mm thickness. Adjacent sheet of wire fabric shall be lapped at least 100 mm and tied.

b. Clear cover to reinforcement mesh shall not be less than 15 mm.

Minimum thickness of shotcreting shall be 50 mm. for abrasion resistant work and 25 mm for ordinary surface protection work.

5.07.20.02 Material

Generally, the materials shall be in accordance with aggregates specification given hereunder.

Fine aggregate shall consist of natural sand or crushed stone from a known source and shall be strong, hard, coarse, sharp, chemically inert, clean and free from any coating. It shall be free from clay, coal or coal residue, organic or any other impurities that may impair the strength or durability of the concrete and shall conform to IS 383.

Fine aggregate (Sand) shall be well graded and particles shall range in size within the following limits. The Engineer, may approved the use of any other grading as per requirement or as per IS 9012.

The fineness modulus shall be preferably between 2.5 and 3.3. Any other value can be used, with prior approval of the Engineer.

5.07.20.03 Application

After the placement of reinforcement and / or welded mesh and not more than six hours prior to the application of shotcrete, the surface shall be thoroughly cleaned of all loose materials and dirt. The Contractor shall properly prepare the surfaces, reinforcement and / or welded mesh to receive the shotcrete. Cleaned surfaces shall be wetted not more than hour prior to shotcreting.

The mix as placed on surface shall be one part cement to three parts approved sand by mass. Cement and sand shall be dry mixed; not water shall be added after mixing and before using in the gun. The quantity of water when added shall be only that which is sufficient to hydrate the cement. For average atmospheric conditions, the water cement ratio for shotcrete in place shall be between 0.35 and 0.5 by mass. Suitable admixture shall be used wherever required.

A uniform pressure of not less than 3 Kg/cm2 at the nozzle shall be maintained. Necessary adjustments shall be made to ensure this pressure, taking into account the length of hose and height of the place to be shotcreted, above location of the machine.

The application shall proceed in an upward direction. Beams, stiffeners and intermediate walls, if any, shall be wrapped with wire fabric and completely covered with shotcreting. All

	rebound shall be removed from the area of application as the work progresses and such rebound material shall not be reused.
	As soon as the freshly shotcreted surface shows the first dry patches, a fine spray of water shall be applied to keep too moist. After the surface has hardened, it shall be kept continuously moist for minimum seven days. If there is extreme heat, especially when accompanied by hot winds, the shotcreted surface, immediately upon completion, shall be covered with burlap or similar covering, which must be kept continuously moist for 14 days after shotcreting. The temperature of the lining shall not be permitted to exceed 38°C during placing and curing.
5.07.21	**VIBRATION ISOLATION SYSTEM**
	These specifications are meant for the design, supply and erection of vibration isolation system for supporting coal crushers (ring granulators).
5.07.21.01	Supporting Arrangement
	The crushers shall be supported on vibration isolation system consisting of steel helical springs and viscous dampers. The supporting arrangement for each crusher shall consist of an R. C. C. deck supported on steel helical spring units and viscous damper units which in turn shall be supported on girders. The girders shall be an integral part of the crusher house building.
	The part of the structure consisting of the R. C. C. deck, springs and viscous dampers shall hitherto be referred to as “spring supported foundation”. The part of the structure, which is below the spring shall hitherto be called “supporting structure”.
5.07.21.02	The Contractor should do the Engineering / design, supply and erection of vibration isolation system consisting of steel helical spring units and viscous dampers supporting the top deck which in turn would support the coal crushers. The vibrations isolation system supplied shall be of a proven make. The Contractor or his sub - contractor who designs and supplies the system should have designed, supplied and installed such systems for not less than five machines of speeds and unbalance forces comparable to the machine proposed by the vendor. The vibration isolation systems installed by the contractor or his sub - contractor in such machines should have been working satisfactorily for atleast five years.
5.07.21.03	**Scope of Work**
	Scope of work shall include the following:
5.07.21.04	**Engineering**
5.07.21.04.1	Design of the vibration isolation system using steel helical springs and viscous dampers to support an R. C. C. top deck supporting the coal crusher. This includes the static and dynamic analysis of the vibration isolation system with the R. C. C. top deck and the coal crusher.
5.07.21.04.2	Structural design of the R. C. C. top deck including preparation of General Arrangement drawings, detailed reinforcement drawings, bar - bending schedules etc.
5.07.21.04.3	Calculation of loads on the structure supporting the springs and viscous dampers, their points of application and the stiffness requirements of the supporting structure.
5.07.21.04.4	Drawings showing embedments and their locations and details on the R. C. C. top deck.
5.07.21.04.5	Drawings showing block outs, recesses etc. on the top deck.
5.07.21.04.6	Design of the supporting structure, including preparation of detailed drawings and bill of materials.
5.07.21.05	**Supply including packing and transportation to site**
5.07.21.05.1	Steel helical spring units and viscous dampers, including associated auxiliaries for installation of the spring units and dampers like steel shims, adhesive pads etc.

5.07.21.05.2	Frame (s) for pre-stressing of spring elements.
5.07.21.05.3	Suitable hydraulic jacks system including electric pumps, high pressure tubes etc. required for the installation, alignment etc. of the spring units, two extra hydraulic jacks, one hand operated pump and spares for the hydraulic jack system as required.
5.07.21.06	**Erection and Commissioning**
5.07.21.06.1	Complete erection and commissioning of the vibration isolation system including :
5.07.21.06.2	Pre-stressing of spring elements, placing of spring elements in position, checking clearances on the shuttering of the R. C. C. top deck, construction of the supporting structure and the R. C. C. top deck, releasing to pre-stress in spring elements and making final adjustments and alignments after machine installation etc.
5.07.21.06.3	The scope of work shall be deemed to include all activities which may not have been explicitly mentioned but are reasonably implied for the successful completion of the work for which these specifications are intended.
5.07.21.06.4	This part of the specifications is for vibration isolation system. For the construction of the supporting structure for the crusher and the top deck, the relevant parts of the specification should be referred to.
5.07.21.07	**Documentation**
5.07.21.07.1	Submission of detailed design calculation, analysis (static and dynamic) and drawings for Employer's acceptance and approval.
5.07.21.07.2	Furnishing methodology of providing shuttering and its removal as well as concreting of deck slab, installation of springs and dampers and the sequence of operation.
5.07.21.07.3	Furnishing installation and maintenance manual indicating equipment, procedure etc., necessary for installation, maintenance of vibration isolation system.
5.07.21.07.4	Furnishing a check list for confirming the readiness of the civil fronts for the installation of vibration isolation system and equipment required at each stage installation.
5.07.21.07.5	Bill of materials of various elements such as springs, visco-dampers, with their rating, stiffness etc., included in supply.
5.07.21.07.6	Detailed specifications of the vibration isolation system and various items included in the supply and the standard (local or international) to which they conform.
5.07.21.07.7	Proposed erection strategy of the entire system.
5.07.21.08	**Design Requirements for Crusher (Ring Granulator) Foundation**
	Dynamic Analysis
	Detailed dynamic analysis shall be done for the top deck together with springs and dampers and the natural frequencies and amplitudes of vibration shall be determined. A mathematical model of the top deck shall be formulated with three - dimensional beam / plate finite elements for the purpose of analysis with the spring idealised with vertical and horizontal stiffnesses. The mass of the machine together with that of the top deck shall be considered for the analysis.
	Natural frequencies upto at least 10 % above the operating speed shall be determined and these frequencies shall be checked against the design criteria.
	Forced response dynamic analysis shall be carried out for the operating condition unbalance forces using a sinusoidal forcing function. Unbalance forces as given by this specifications shall be used for his purpose. The amplitudes shall be checked against the design criteria. The dynamic forces from this analysis shall be used for structural design with a suitable fatigue factor.

Isolation Efficiency

The vibration isolation system shall be designed for about 90 % isolation efficiency.

De-coupling

A ratio of the least 10 (ten) shall be ensured between the stiffness of the supporting structure and the stiffness of the spring system in the vertical direction to achieve de-coupling between the two (the stiffness of the spring system being lower). This ensures that dynamic analysis of the supporting structure need not be carried out.

Frequency Criteria

The frequency criterion has already been laid down implicitly by the isolation efficiency criteria and de-coupling required.

The first bending mode frequency of the top deck shall be at least 20 % above the operating speed.

Unbalance Forces

Unbalance forces arising out of all the following cases shall be considered for checking the design and amplitudes.

a. Balance quality grade Q 40 as per VDI 2060 - 1966.

b. One hammer broken condition. The missing hammer shall be assumed to be closest to the crusher non - drive end of the crusher.

c. Three hammers broken condition. All the three hammers broken shall be assumed to be from the same suspension bar and located at the non - drive end of the crusher.

Amplitude Criteria

The calculated amplitudes (mean to peak values) shall not exceed following limits under the specified conditions.

1) Operating speed of 750 RPM

a. 150 microns for an unbalance force arising out of balance quality grade Q 40 as per VDI 2060 - 1966.

b. 300 microns in case of a one hammer broken condition.

c. Amplitudes need not be checked for a three hammer broken condition.

d. Operating speed of 450 RPM

e. 200 microns for an imbalance force arising out of balance quality grade Q-40 as per VDI -2060-1966.

f. 400 microns in case of a one hammers broken condition.

Amplitude need not be checked for a three hammer broken condition.

For intermediate operating speed between 450 to 750 RPM the amplitude limits can be linearly interpolated.

The amplitude limits mentioned above are in both vertical and horizontal directions. The amplitudes shall be calculated at critical points on the top surface of the R. C. C. deck. The amplitudes shall be checked for the most unfavorable superposition of modes in any direction. However, phase difference between the maximum amplitude occurring in different directions due to the rotating vetor may be considered while superimposing the modes.

5.07.21.09 **Transient Resonance**

Transient resonance, which may occur during the start - up or coasting down condition of the crusher, shall be checked, and the amplitudes in such a condition should not exceed one - and - half times those at operating speed for each design condition.

5.07.21.10 **Strength Criteria**

The following criteria shall apply for the design of top deck :

a) Dead loads, live loads, Seismic loads and dynamic loads shall be considered for the design. The most unfavorable combination shall considered for design.

b) Seismic loads shall be assumed to act together with dynamic loads for a one millimeter eccentricity in the rotor. However, seismic loads and dynamic loads arising out of hammer breakage need not be considered together

c) Fatigue shall be considered while designing for dynamic forces. A fatigue factor of 2.0 shall be used on all dynamic forces to arrive at the equivalent static force for the purpose of design.

d) Working stress method shall be used for the design of R. C. C. deck. In survival condition, 10 % overstressing may be permitted.

e) The R. C. C. top deck shall be at least of M25 grade of concrete as per IS : 456 - 1978.

f) Fatigue need not be considered for the three hammer broken condition.

g) For calculating unbalance forces, the heaviest hammer (plain or toothed) shall be considered.

5.07.21.11 **Approval of Designs and Drawings**

All design calculation, drawings and documents shall be in English. All design calculations and drawings shall be submitted to Employer for approval. However, approval of such designs and drawings shall not relieve the contractor of his responsibility regarding the adequacy of the foundation to carry the design forces.

5.08.00 **Ash Handling System**

5.08.01 The civil works for Ash handling system shall comprise of bottom ash and fly ash handling systems, ~~which includes Ash water~~ pump house and their related sumps/tanks, Transport Air Compressor house, Switchgear /Control/RIO rooms, foundations for Bottom ash hopper, Buffer hoppers/Collector tanks, bottom ash silos , Silo Utility Building complex with Fly Ash Silos including development of silo area (i.e. paving, fencing/boundary-wall, access roads, office block and watchman cabin), miscellaneous equipment foundations, trenches, pipe racks, transfer points, foundations for conveyor supports (both inside and ~~outside~~ the plant boundary) including bridges/ culverts for road/rail/nallah etc., as required

5.08.01.1 All Buildings for Compressor house, Silo utility building and pump houses shall be designed as per type of building requirement specified elsewhere in the specification. Other buildings like MCC /switchgear rooms, control room etc. will have RCC framed structure with cast-in-situ RCC roof slabs. All buildings shall have brick cladding. Crane girders or mono rails shall be provided as per requirement and the same shall be of structural steel construction.

5.08.02 The documents and drawings as listed below are to be submitted for the approval of the Employer unless specified otherwise. The list given below is not exhaustive but indicative only.

a) Project design intent document giving the basis of design, which shall cover all the design philosophy aspects, parameters, assumptions, references, loading cases, load

	combinations, analysis and design of all buildings, structures, facilities etc. shall be furnished for approval, before commencement of detailed engineering. b) Structural analysis, design calculations and drawings of substructures and super structures for all buildings/structures, facilities like pump houses, compressor houses, sumps / tanks, channels, pipe support structures, culverts/ bridges, pedestals, thrust blocks transformer yards, etc shall be submitted for approval of the owner. c) The design and drawings for the equipments and their supporting structures like bottom ash hopper, buffer hopper/collector tanks, surge tank/settling tank, silos/bins, etc. associated with Ash Handling System, shall be submitted to NTPC for information only. However, the structural design criteria and basis of design as mentioned at (a) above, for these structures also shall be approved by the Owner. d) Top of RCC pedestal of foundation for bottom ash hopper, fly ash silo, HCSD Silo, other columns etc. shall be 300 mm above paving level or surrounding finished ground level (FGL).
5.08.03	Deleted
5.08.04	The Silo utility building complex shall be fenced with chain linked fencing, if placed inside the plant boundary and shall be confined with boundary wall if placed out side plant boundary. Gates shall be provided for rails, truck movement and transformers. The boundary wall shall be of one brick thick of height 2.4 m with a 600 mm high galvanized concentrina at top, such that total height is 3.0 m above formation level. The fencing shall be PVC coated G.I. Chain link of minimum 4 mm thickness (including PVC coating) of mesh size 75mm x 75 mm and of height 2.4 m above toe wall .The toe wall shall be 1 brick thick, minimum 200 mm high above paving/formation level and 300 mm below paving/formation level on 75 mm thick PCC(1:4:8) bedding. Entire area in the silo area complex shall be paved and have a peripheral RCC drain of adequate capacity & slopes covered with perforated precast RCC slabs of minimum 50 mm thickness with provision of openable galvanized steel grating covers of 1.0 m at every 4 m interval .The complex shall be provided with a sump for collection of ash water. In addition to the outer confinement, additional fencing with gates should be provided for all transformers in the complex. A watchman cabin with a minimum area of 5 Sqm shall also be provided in this area.
5.08.05	The foundations & pedestals for conveyor supports including bridges/ culverts for road/rail/nallah etc., shall be provided as per the system requirement. Pipe supports shall be provided dust suppression pipes, dry fly ash(FA) pipes including RCC thrust blocks and any other supports required to complete the system. Over-ground pipes shall be supported on RCC pedestals except for FA pipes which shall be on steel trestles. Unless noted otherwise, the top of concrete pedestals for pipes shall be minimum 500 mm above surrounding ground level and 200mm above paving level in paved areas. Pipes shall be suitably anchored with RCC pedestals to resist lateral and vertical movements as per system requirement.
5.08.06	Deleted
5.08.07	If the layout requires the pipes to cross the road on top of ash dyke / road, all pipes shall be laid in hume pipes of suitable dia (NP-3 class) encased in RCC(minimum 200 mm thick) forming a hump on the road. The road shall be modified such that the slope of road along the length, at hump section, shall not be steeper than 1:20.
5.08.08	Single lane maintenance / Inspection road with 1.5m wide shoulders on both sides of the road shall be provided along the route of the ash slurry pipeline from plant boundary wall to the ash dyke along ash pipe lines. The details of road shall be as specified elsewhere for patrol road in the specification. However shoulders shall consist of 150mm thick compacted layer of moorum in place of interlocking blocks specified therein. For stretches of roads in cutting and other stretches wherever necessary, longitudinal rectangular brick side drains with minimum 500 wide and 300 deep shall be provided. Only,the inside faces and top surfaces of the drains shall be plastered with 1:4 (cement : sand mortar) . These drains shall be connected to the nearest available natural drain or low lying area. Adequate cross

	drainage with RCC box culvert or RCC pipe culverts (NP-3) as per topography requirement shall be provided under the access/maintenance road to cater to the surface drainage due to rainfall and other existing drain/nallah . Camber shall be provided on the road. The finished top (crest) of all roads shall be minimum 350 mm above the surrounding finished ground level, however based on the site conditions / low lying areas the height of road top shall be increased. However, in the complex near ash mound it shall be minimum 250 mm above FGL.
5.08.09	Where the pipes are crossing the road through RCC box culverts, the culvert top generally, shall not be not more than 100 mm above the road top and a hump with slope of 1:35 shall be provided on the road. All other road crossings inside the plant area can be either underground or overhead road crossings with necessary headroom clearance. For any boundary wall crossings, pipe shall be laid through casing pipe / RCC culvert. After laying the pipe, the boundary wall shall be restored. For other water body crossings, such as local Nallah / canal, local water bodies, local drains etc. suitable structural arrangement with 800 mm wide walkway shall be provided. Minimum clearance of the bottom of pipeline for all such locations shall be 1.50 M above the High flood level (HFL). Bidder to take all statutory clearance from concerned authorities for crossing his pipe/trestles over road / rail / culverts / nallah etc. at his own cost and initiative, without any commercial implication to the owner. For any other additional works, bidder have to make their own assessment too of the quantity/ number of culverts, existing pipe pedestal crossings, nallah crossings etc., based on their site visit before quoting.
5.08.10	Deleted
5.08.11	Survey inside ~~and outside~~ plant boundary, required for finalization of layout for maintenance road , FA transportation pipe trestles, conveyors up to etc upto silo area in the bidder's scope. The survey shall include the longitudinal section of the entire corridor
5.08.12	All liquid retaining structure shall be designed by working stress method as given in clause 4.5 of IS 3370(Part-2):2009.
5.08.13	The thickness of base slab in liquid retaining/ carrying structures shall be minimum 150mm
5.08.14	The minimum reinforcement in each direction shall not be less than 0.24% of the gross cross-sectional area.
5.08.15	All liquid retaining structures shall be tested for leak proofness with full water level in accordance with clause no.12 of IS:3370(Part 1):2009 and IS:6494.
5.08.16	All pump houses and other substructures shall be checked for stability as per the following guidelines: a) Stability of structure against sliding during construction as well as operating conditions for various combinations of applied characteristic loads. In case where dead load provides the restoring moment, only 0.9 times the characteristic dead load shall be considered. Factor of safety against sliding shall not be less than 1.4 under most adverse combination of applied characteristic loads. b) Stability of structure as a whole against overturning. It shall be ensured that the resisting moment shall be not less than the F.O.S. times the maximum overturning moment. Factor of safety against overturning shall not be less than 1.2 due to characteristic dead load and shall not be less than 1.4 due to characteristic imposed load. c) Stability of structure against uplift due to the ground water table at finished ground levels during construction and after construction stages. Minimum factor of safety of 1.2 against uplift shall be ensured considering 0.9 times dead weight, empty condition inside and ignoring the superimposed loadings. Inclined wedge action shall be limited to 15 degree with vertical plane. Provision of pressure relief valve / flap valves etc. shall not be permitted to counter the uplift. Also FOS against uplift, to be taken as 1.0 considering the dead weight of structure and soil resting on side

projections, if any, in the vertical plane. Inclined wedge action of soil shall not be considered in this case.

5.08.17 **Architectural Features of Ash Handling System Buildings:**

a. All the buildings shall be fully covered with brick masonry cladding and doors/ windows/ rolling shutters / ventilators.

b. Safety norms shall be followed as applicable. The buildings shall be provided for Pump houses, Switch Gear Room, Control Room etc. as per ash handling system requirements.

External finish shall be of premium acrylic smooth exterior paint with silicone additives over suitable primer of waterproof cement paint.

5.09.00 **Sewerage System**

Bidder shall provide 'De-centralised Sewage Treatment ' units should be as per the design requirements, subjected to minimum combined capacity of 75 Cum/day. De-centralised Treatment units shall be of Sintex (PWTS-STBF or NBF) or Ion-exchange (NGPSTP) make or equivalent. Alternatively, bidder may provide a 'Centralized Sewage Treatment Plant' for complete plant facilities with minimum combined capacity of 75 cum/day and MBBR technology shall be used for centralized sewerage treatment plant.

Complete sewerage system including Sewage Treatment Plant for facilities within the plant is in bidder's scope.

Cement concrete pipes of class NP-3 as per IS:458 shall be used below ground level for sewage disposal in all areas other than main plant area. However, for pressure pipes and in main plant areas, and under roads spun C.I. pipes conforming to IS:1536 of required class shall be used.

RCC manholes with CI cover shall be provided at every 30m along the length, at connection points, and at every change of alignment, gradient or diameter of a sewer pipeline. This shall be as per IS:4111.

Sewage pump house shall be provided as per IS:4111.

Sewage treatment plant is to be provided by the Bidder. Bidder shall have to provide complete arrangement for sewage disposal up to the Sewage treatment plant including pumping facilities. Extended Aeration method of sewage treatment shall be used.

5.10.00 **Plant Storm Water Drainage System**

Complete storm water drainage system of all areas is in bidder's scope. Total compliance of detailed `Area Drainage Study' report in respect of drains inside plant boundary and its connections to natural drains/river outside the plant boundary area (report attached as Annexure -3) will be in bidder's scope. The drain dimensions shall be based on "Area Drainage Study" report. Any Storm water drain not envisaged in "Area Drainage Study" report, dimensions of such drain shall be designed as per basis given in "Area Drainage Study" report. All RCC drains shall be either RCC Cast-in-Situ or RCC Pre-cast drains. The minimum grade of concrete shall be M25 for RCC Cast-In-Situ drains and M30 for RCC Pre-cast drains.The drain clear dimensions at any point should not be less than 0.75m (height) x 0.75m (width).

Open RCC rectangular section, unless required otherwise due to functioned requirement, shall be provided for all drains. The thickness of side walls and bottom slab of RCC drains shall be minimum 150mm or as per design considerations whichever is higher for drains upto depth of 1m from formation level. For depth of drain more than 1m from formation level, the thickness of side walls and bottom slab of RCC drains shall be minimum 200mm or as per design considerations whichever is higher. The drains shall be provided on both sides

of the double lane roads and single lane roads. The drains shall be provided on one side of the patrol roads. These shall be designed to drain the road surface as well as all the free and covered areas, etc. Box culverts shall be provided at all rail, road and other crossings.

All plinth drains along the periphery of all buildings other than BTG area shall have perforated pre-cast RCC cover of minimum 50mm thickness. The drain in BTG areas shall be covered with cast in situ/ pre-cast RCC covers with minimum 200 mm thickness designed for all crane / vehicular loads. All drains in the BTG area shall also be provided with heavy duty galavnised MS grating with opening of 1m x1m at 7.5m interval.

All drains inside the building shall have minimum 40 mm thick grating covers. In areas where heavy equipment loads would be coming, precast RCC covers shall be provided in place of steel grating.

The invert levels of the in-plant and plant peripheral drains shall be kept such that water can be discharged by gravity to the main / trunk drains under all conditions.

The invert levels of the drains shall be decided in such a way that the water can easily be discharged to the natural water bodies above the high flood level.

5.11.00 Diversion of Existing Drainage And Discharge Of Plant Drainage Into Natural Drainage System

All existing drains crossing the project / site shall be diverted suitably and shall be discharged into a natural drain outside the plant boundary as per the “Area Drainage Study” report. The corridor for drain diversion with maximum width of 10m shall be used for the diversion of drains surrounding the plant area. The section for diversion drain shall be as per “Area Drainage Study” with recommended sectionwith lined sections. The sections as mentioned of Area Drainage Study report, shall be followed for the diversion of drains.

5.12.00 Roads

All roads shall be of rigid pavements unless otherwise specified. The design of rigid pavement shall be carried out as per IRC: 58. The effects of design wheel load, maximum tyre inflation pressures, tyre contact area for the vehicle, traffic loads, environmental factors such as temperature changes in the pavement, other factors, like impact, load repetitions, etc., are to be taken. Detailed plate load tests to determine the modulus of sub grade reaction “K” shall be carried out as per the procedure outlined in IS: 1888. The design traffic load shall be a minimum value of 4 million standard axles. The road shall be designed for 30 years of life and considering a minimum traffic growth rate of 1 per cent per annum. The concrete pavement for roads shall be minimum 250 mm thick slab.

The road construction including its shoulders, base, sub base and concrete pavement shall be as per IRC standards. IRC: 58 shall be followed for the pavement design and IRC: 15 shall be followed for the construction of the concrete pavement.

The road base shall be with minimum 150 mm thick dry lean concrete over granular sub base. Dry lean concrete shall be laid by a mechanical paver and compacted by vibratory rollers. Concrete pavement of the road shall be done with fully mechanized paver fitted with electronic sensors for construction techniques. Dry lean concrete shall be minimum M10 grade and concrete pavement slab shall be minimum M35 grade concrete.

The finished top (crest) of all roads shall be 350 mm above the surrounding finished ground level.

The sub grade under all roads and its shoulders shall be compacted to achieve 95 per cent or more of Standard Proctor's Density MDD using mechanical means.

Cutting / extending / rerouting / remaking of existing roads including associated works to maintain continuity of road system / network shall also be carried out.

All culverts and RCC bridges at crossings of all roads / rail tracks / facilities with drains / nallahs / channels / roads / rail tracks / pipes / other facilities, etc. are to be designed and constructed.

Unless otherwise specified, all roads (excluding access roads to all buildings / facilities / structures, patrol road along boundary wall and road inside the switchyard) shall be double lane roads.

5.12.01 **Double lane roads:**

The double lane roads shall be (12 metres wide) with 7.5 metres wide concrete pavement and 2.25 metres wide raised shoulders on both sides of the roads.

The raised shoulders (on both sides of the road) shall comprise of 75mm thick inter locking precast designer concrete blocks (M35 grade) at the top, over 20 mm thick sand layer. A 200mm diameter NP3 pipes shall carry the surface water from the road through a PCC drain trench (M20) on both sides of the roads to the drain. The pipes shall run over PCC (M 20) continuous cradle bedding. The pipes shall be laid at 10 metrescentre to centre. A layer of 100 mm (average) thick PCC (M15) shall be laid over the pipes and below the sand layer. All roads shall be provided with edge protection on both sides of the road using pre - cast kerb blocks (450 mm long x 250 mm wide x 500 mm deep) (M25) laid in 1 (cement) : 6 (coarse sand) cement mortar.

5.12.02 **Single lane roads:**

All access roads to all buildings / facilities / structures, road approaches / connections, access roads to liquid fuel storage areas and other equipment areas where access is necessary from inspection, operation and maintenance point of view and all roads inside the switchyard shall be single lane roads. These shall be single lane roads (5.75 metres wide) with 3.75 metres wide concrete pavement and 1 metres wide shoulders on both sides of the roads. The shoulders shall also have 150 mm thick dry lean concrete and 75 mm thick inter locking blocks over compacted granular sub base of two layers of 75mm thick WBM grade III 53-22.4mm. All roads shall be provided with edge protection on both sides of the road using PCC blocks (300 mm long x 250 mm wide x 150 mm deep) (M25) laid in 1 (cement) : 6 (coarse sand) cement mortar.

5.12.03 **Patrol roads:**

All patrol roads along the boundary wall shall be single lane roads with 3.75 metres wide concrete pavement and 1 metres wide shoulders on one side of the road. The shoulders shall also have 150 mm thick dry lean concrete and 75 mm thick inter locking blocks over compacted granular sub base of two layers of 75mm thick WBM grade III 53-22.4mm. All roads shall be provided with edge protection on both sides of the road using PCC blocks (300 mm long x 250 mm wide x 150 mm deep) (M25) laid in 1 (cement) : 6 (coarse sand) cement mortar. The road shall slope towards the inner drain. The centre line of ~~the black top of~~ the road shall run at a distance not less than 2625 mm from the centre line of the boundary wall.

5.13.00

Administration Building

Salient Features

The Administration Building shall be a multi–storied RCC frame superstructure. The building shall have an RCC Lift structure accommodating the Lifts. The structural framing plan and elevations shall be based on the architectural concept to be developed by the bidder. The minimum thickness of Lift Superstructure RCC Wall shall be 230mm.

Design Concept

The building shall be designed as moment resisting RCC sway frame in both the orthogonal directions. For general design guidelines IS 456 shall be followed and for ductile detailing (against seismic load) IS: 13920 shall be followed.

Architectural Features

This building shall be four storeyed (G+3 stories above)and area 4000 sq.m. with RCC Frame structure& Autoclave Aerated Concrete Block masonry. Floor-to-floor height shall be minimum 4.50m. The building shall have a central atrium covered with polycarbonate sheet dome.Top floor of the building shall be dedicated to Full Scope Training Simulator with following requirements:

Simulator Training Room (Air conditioned): 15m x 12m

Battery Room (Ventilated) : 10m x 5m

UPS Room (Air conditioned) : 10m x 5m

Programming Room (Air conditioned) : 6m x 5m

Class Room (Air conditioned) : 6m x 5m

Faculty Room (Air Conditioned) : 6m x 5m

Maintenance Engr Room (Air conditioned) : 5m x 5m

Hermetically sealed double glazing with toughened Glass to be provided for external glazing.

There shall be provisions for Exhibition Hall, Conference Room for 50 persons, Canteen for 30 persons, Bank, Bank ATM space, AHU.,MCC Room, First Aid Centre, Library, offices. Separate toilet facilities shall be provided for ladies and gents in each floor. One toilet shall be provided for physically handicapped at each floor. The building shall have provision of attached toilet with the cabin for senior executives and conference rooms.

2Nos Panoramic Lifts and minimum 2Nos stairs shall be provided.Lift shaft shall be of R.C..C wall.

Covered parking space for 25 nos. cars shall be provided. Covered parking shall be of RCC construction. Open parking space for 40 nos. cars & 75 nos. scooters shall be provided. Minimum 23 sq.m./car (including circulation area) and 5 sq.m./Scooter (including circulation area) shall be considered for working out parking space.

The Admin building shall be fully IT enabled. 300x40 mm GI Raceway with standard length 2500 mm single compartment trunking raceways made from 14 gauge (minimum) pre-galvanised sheet including fasteners, floor support, connectors, bends cross-way, earthing stud for fixing etc. complete as per requirement, drawings and instructions of EIC shall be laid under floors of service building for IT enablement. 350x350x50 mm Junction boxes of pre-galvanised sheet with cover plate for raceways shall also be provided. Minimum 70mm Floor finish margin shall be kept for installing metallic raceways.

The rain water down comers shall be provided as per General architectural specification.The rain water down comers shall be suitably concealed by the external wall enclosure.

~~External finish shall be combination of Premium acrylic smooth paint with silicone additives~~

External finish shall be combination of GRC Tile & aluminium composite panel. The GRC Tile of size 250mmx75mmx15mm. (Minimum dimensions) in approved design, size, texture, thickness, pattern and color. The Tile shall confirm to IS :1237-1980. The composition of tiles should be `43' Grade White Portland cement, reinforced with Alkali Resistant Glass Fiber and the pigmentation should be done with exterior grade synthetic inorganic iron oxide pigments. The pigmentation should be homogeneous and in accordance with British Standards BS EN 12878:1999. The other additives should be fine washed graded quartz, super plasticizers and integrated water proofing agents and others. The tiles should be produced with high vibration technology and should have compressive strength equivalent to M-40 Grade@28 days. The top surface of the tiles should be sealed with acrylic lacquer resulting in surface water absorption of tiles, less than 1% and water absorption by 24 hrs immersion method, less than 8%. The tiles should be applied on a rough plaster of cement mortar 1:3 (1 cement: 3 coarse sand) and the fixing of tiles should be done by tile adhesive as per manufacturer's laying instruction

&~~aluminium composite panel~~

5.14.00 Plant Auditorium

Salient Features

Plant Auditorium shall be a RCC framed superstructure. . The building shall have large span Roof structure over the Auditorium Hall. The large span roof structure shall comprise either RCC beams (with camber at bottom surface) and roof slab or structural steel girders/ roof truss (with adequate lateral stability through tie & rafter level bracings / girders in orthogonal direction) and RCC slab over profiled metal deck sheets with purlins.

All the external wall shall be of Autoclaved aerated concrete block wall 250 thick for this fully covered Auditorium with additional internal & external plastering. Handrail for all balconies & staircases shall be made of stainless steel. Floor wall and false ceiling details shall be as per architectural specification.

Architectural Features:

This building shall be of RCC Frame structure& Autoclave Aerated Concrete Block masonry. The area of building shall be 1200 sq.m.and shall have seating capacity of 150 persons.

There shall be provisions for Main Entrance Foyer, Lounge, AHU, AC Plant room, MCC room, stage, Green rooms, pantry etc. Separate toilet facilities shall be provided for Ladies & Gents& physically handicapped people.

Plant Auditorium shall be centrally Air Conditioned Building

~~service areas shall be keptand Coloured Aluminium Composite panel~~. False ceiling & wall panelling shall be provided as per Acoustical consideration.

The rainwater down comers shall be provided as per General Arch. Specification and they shall be suitably concealed inside wall enclosure.

External finish shall be combination of GRC Tile & aluminium composite panel.

5.15.00 Main Gate Complex & CISF Building

The Gate Complex shall comprise two(2) mild steel vehicle entry gates of minimum 8.0m width and height 3.0m and shall be electrically operated. Minimum one room for security personnel shall be located at each end of the gates.

Two(2) separate mild steel pedestrian gates minimum 3.0m high and 3.0m width shall be provided at the each end.

The Central Industrial Security Force (CISF) Building shall be a two (2) storied RCC super structure with office complex in ground floor & first floor. The building shall be constructed with 250mm thick brick wall with provisions for doors, windows & ventilators. The first floor shall also have a viewing gallery. The floor area and architectural details shall be as per the Arch spec. mentioned hereafter in this Specification.

Design Concept:

The CISF building shall be designed as moment resisting sway frame in both orthogonal directions and shall be designed as per IS: 456, IS: 1893 and IS: 13920 (for seismic ductility requirement) and as per design criteria mentioned hereafter in this specification.

Architectural Features

The CISF Building shall be 2-storied building. It shall be of RCC Frame structure& Brick

masonry. The floor area of this building shall be minimum 700 sq m

The Gate Complex and CISF building shall have sufficient no: of guards rooms to regulate movement of men and material and overall security, using latest modern technology like turnstile type/ boom type access control with magnetic cards and close circuit TV sets, computerized time and security office, etc shall be made. For any other gate provided for entry or exit, provision for a suitable small security hut/shed shall be made.

covered

Space provision for CISF personal staff, time office including time machine, reception, lounge, Arms store, Detention Room, Conference room, Toilets and pantry shall be provided as per functional requirement including toilets for Ladies, Gents, Physically handicapped.

The provision for car and scooter parking shall be made. 20 nosCar parking (23 sq.m./car including driveway), Scooter parking- 20 (5 sq.m./Scooter).

In addition, provision for space for open parkingfor5 trucks, &20 cycles shall be provided.

External finishing shall be of Premium acrylic Smooth Paint with silicone additives& Aluminium Composite Panel combination.

Gates Along Boundary Wall:

The gates shall be provided at the entry & exit points of ash bulker movement road, at the entry of railway line, at the entry of material access road to the plant, at the entry of plant from township. No. of gates in Bidder's Scope are as identified in General Layout Plan Drawing No.: 9585-999-POC-F-001.

The gate shall comprise of two mild steel double panelled openable shutter of minimum 7.75 m clear width and minimum height of 3.0m from top of road.

The gate shall be complete with fabricated hinges, MS aldrops with locking arrangement, tempered steel pivot, guide track of MS tee, bronze aluminum ball bearing, castor wheel etc.

All gates shall be given anti-corrosive treatment in three coats.

The structural steel shall confirm to IS: 2062 (latest) and all other relevant IS codes.

Beside the each gate one room of size not less than 3m X 3m shall be provided for security guards. The room shall be made of brick/ RCC and with RCC roof. In addition to the room, one toilet block shall also be provided.

5.16.00 Permanent Store Building

Salient Features:

The scope of work of the Bidder shall be design & construction of all Civil, Structural, and Architectural, Water supply, plumbing & sanitary works of the Permanent Store Building including supply of all materials.

The Permanent Store Building shall comprise the following

a) Heavy Material Storage Hall

b) Light Material storage Hall (With 3 tier Racking System)

c) General Light Material Storage Hall

d) Office Complex.

a) The Heavy Material Storage Hall shall have a Single Bay framed superstructure with RCC/ Structural steel columns and structural steel roof truss. The roof of the Heavy Material Store shall be 40mm thick RCC slab (with additional water proofing) supported on permanent coloured metal deck sheet. An EOT crane shall be provided with chequered plate walkways at both ends inside the bay of the Heavy Storage Hall. The capacity of the EOT crane shall be 30 T. The clear height up to the bottom of roof trussof the Heavy material storage hall shall be finalized based on equipment/ spare to be handled.

b) The Light Material Storage Hall with 3 tier Rack system shall have a Single Bay framed superstructure with RCC/ structural steel columns and roof truss. The roof of light material Light Material Store shall be 40 mm thick RCC slab (with additional water proofing) supported on permanent coloured metal deck sheet. The light material store shall be fully covered with external brick wall of 250 mm thickness with provision for doors, windows, rolling shutters as per architectural concept.

c) The General Light Material Store shall be RCC structure with cast-in-situ RCC beams &slabs.The RCC building shall be two storied and all beam-column joints shall be designed and detailed for adequate ductility.

d) The office complex of this store shall be a single storeyed RCC building.

Architectural Features

Total floor area of the Permanent store building shall be 3000sqm.

The minimum clear floor area of Heavy material storage Hall shall be approximately 20% of the total floor area of the Permanent Store with bay width of 15m.Heavy material store shall have column free space for easy movement of materials.The Heavy Material Storage Hall shall be fully covered with external brick wall of 250mm thickness with provisions for doors, windows, rolling shutters as per architectural concept.

The minimum clear floor area of Light Material Storage Hall (with 3 tier storage) shall be approximately 33% of the total floor area of the Permanent Store. The height of the Light Material Storage Hall (with 3 tier rack system) from ground floor slab to bottom of roof truss shall be 10.0m. A part of light material store shall have facility for storing electronic equipment / instruments. This particular area shall be air-conditioned for dust proof environment.

The General Light Material Store shall be two storied building, completely covered with 250mm thick brickwork, doors, windows & rolling shutters. The plan of the building shall be rectangular in shape with minimum floor area of approximately 20% of the total floor area of the Permanent Store.

The area of the office complex building shall be approximately 17% of the total floor area of the Permanent Store, with clear height of 4.0m . The external Wall shall be 250mm thick brick wall with provisions for doors and windows.

The central office shall be provided for management and monitoring the stored materials. Adequate space shall be keptfor loading unloading of materials. Office shall space for Supervisor/In-Charge room, general office cum record-documentation area, toilets, pantry, etc. shall be provided as per requirement.

All the above mentioned four buildings shall be interconnected by means of a covered passage 5.0m wide.

External finish shall be of Premium Acrylic Smooth Paint with Silicone additives

5.17.00 **Facilities to be provided inRailway siding & ~~CHP area~~**

Railway siding work (both inside and outside plant boundary) is not in the scope of bidder. However, the Bidders' scope shall include the following works for inplant Rail yard:
a) Site levelling of the complete inplant Rail yard as per RDSO guidelines/specs (i.e. complete Block 7 as shown in site levelling plan drawing)
b) Patrol road along the boundary wall as shown in General Layout Plan drawing.
c) Approach roads to facilities/buildings in the Bidder's scope.
d) **Trunk drains for overall drainage of Block 7 is in bidders scope. Internal drainage of block 7 is in owner's scope**.
e) Drains from the buildings and facilities in the Bidder's scope to the trunk drains.
f) A tap off near H2 plant (refer General Layout Plan for location) for potable water supply for 50 users and a separate tap off for fire protection to Railway cabin/loco shed.
Construction of bridge/ culverts for facilities/ systems of the bidder crossing the Rail tracks/ yard (above or below the track) inside plant boundary for the following shall be in the scope of the bidder:
1. Crossing of pipe/ cable galleries/conveyors
2. Crossing of drainage/ sewerage system or any other crossing.
Bidder shall ensure that the design of bridges/ culverts or any other structure crossing the Railway tracks are as per Railways/ RDSO guidelines/specifications for DFC 32.5T loads. The scope also includes getting approvals from Railways before start of construction work. Construction of these structures is to be done as per Railways guidelines. Any statutory charges payable to Railways/ RDSO for approval & execution of the above crossings shall be borne by the bidder. Engagement of approved Railway Consultant for the above work by the bidder would be at his own cost.
However, for design of the above crossings above rail track, the following minimum clearance from Rail track shall be maintained:
A. **Horizontal clearance**: A minimum clearance of 3.5m shall be maintained between centre line of the Railway track to face of the crossing structure.
B. **Vertical clearance**: A min vertical clearance of 8.5m shall be maintained between Rail top level and bottom of structure. Bidder has to submit to the owner two sets of railway approved drawings and two sets of (hard & soft copies) as built drawings. The construction of rail network inside the plant for transportation of coal, fly ash
& POL is in the scope of Owner. The bidder should plan to complete the construction work of all roads/ drainage/ pipe line/ cable crossings etc which are crossing below the rail track well in advance to facilitate owner to undertake the construction work of siding

carryout any modifications as required by the RDSO/Railway authorities at no extra cost to the Owner. Bidder has to submit to the owner two sets of railway approved drawings and two sets of (hard & soft copies) as built drawings to the owner.

The construction of rail network inside the plant for transportation of coal, fly ash & POL is in the scope of Owner. The bidder has to complete the construction work of all roads/ drainage/ pipe line/ cable crossings etc which are crossing below the rail track well in advance to facilitate owner to undertake the construction work of siding.

5.18.00 TECHNICAL SPECIFICATIONS FOR PRE-CAST BOUNDARY WALL

A pre-cast boundary wall all around the land acquisition line as shown in the General layout Plan for plant area shall be provided. The total height of boundary wall shall be 3600mm above formation level (natural ground level in case formation level is less than natural ground level). Upto height of 3000mm it shall be constructed with precast reinforced cement concrete panels / cast in situ RCC panels and over that for 600mm concertina coil with maximum loop spacing of 125mm shall be provided with Y-shaped MS angle. The RCC precast/cast in situ reinforced concrete columns shall be provided at spacing not more than 2500mm centre to centre.

The RCC precast/cast in situ reinforced concrete columns and footing shall be minimum 1500mm below finished formation level with suitable foundation designed for horizontal and vertical loads. The precast reinforced concrete panels/ cast in situ RCC panels shall be at least 600m below formation level. The RCC precast concrete columns/ cast in situ RCC panels of minimum size 300mmX350mm shall be provided with two grooves of minimum size 115mmX50mm, so as to receive Precast Concrete RCC panels spanning from column to column with minimum width of 600mm and minimum thickness of 100mm as filler wall. The grade of concrete for all precast/cast in situ work shall be of M30 grade conforming to IS 456.

However, foundation / footing shall not rest in filled up strata.

The boundary wall shall be designed as per relevant IS codes and as per standard practices. The same shall be submitted to Owner for approval at the time of detailed engineering, The architecture of boundary wall shall be finalized in consultation with Owner. The precast/ cast in situ reinforced cement concrete coping with minimum projections of 150mm on each side shall be provided at the top of the precast reinforced cement concrete panels / cast in situ RCC panels with suitable provision for MS angle Post for concertina throughout the boundary wall. Opening for gates/drains and for other crossing shall be suitably provided as per the requirement.

All exposed concrete surfaces of all precast members/ cast in situ RCC members have high quality shuttering finish with tolerance of +/- 5mm. Plinth protection of 150mm thickness PCC (M20) shall be provided on both side of boundary wall extending upto 300mm from centre line of boundary wall. High quality shuttering to be approved by Owner.

5.19.00 FIRE WATER PUMP HOUSE, FIRE WATER BOOSTER PUMP HOUSE& FOAM SYSTEM

Salient Features:

The scope of the Bidder shall be design and construction of Civil, Structural, Architectural, Water Supply, Plumbing and Sanitary Works of Fire Water Pump House, Fire Water Booster Pump House and foam system including supply of all materials.

The fire water Pump House shall be single storeyed and single bay RCC superstructure. The building shall be fully covered with external brick wall with provision for doors, windows, rolling shutters and exhaust fans.

The Fire Water Booster Pump House shall be a single storeyed RCC superstructure. The building shall be fully covered with external brick wall with provision for doors, windows, rolling shutters and exhaust fans

Steel shed with roof covering and sides open shall be provided for foam system including associated civil works for foam bladder tank foundations, grade slab, pipe pedestals etc.

5.20.00 Not used

5.21.00 **Fuel Oil Handling system**

The civil works are to be provided for following fuel oil handling system areas as mentioned below:

a. Fuel Oil pressurizing pump house.

b. Foundation and dyke wall and all associated works for LDOtanks.

c. Pedestals and foundations to support the interconnecting piping between LDO tanks to the pressurizing pumps as well as piping from tanker unloading area to the Unloading pump house and further on to the LDO tank and also pedestals from railway unloading trench to unloading pump house

d. Tanker unloading platform.

e. Fuel Oil Unloading Pump House.

f. Oil water separator pit.

Fuel Oil Pressurising Pump House

Salient Features:

This building shall be a single storeyed framed superstructure with RCC columns, structural steel roof truss(with rafter and tie level plan bracings), purlins and roof slab. The roof slab shall comprise 40 thick RCC slab supported on profiled metal deck sheet. Waterproofing on Roof slab shall be done as per architectural specifications. The building shall be completely covered with 230mm thick brick wall with provisions for Doors, windows, rolling shutters. the building shall have separate enclosures for the control room and the switchgear room. All rainwater down comers shall be concealed with brick wall. The minimum floor area of this building shall be as per the equipment layout plan of the bidder/ EPC contractor.

Design Concept:

The grade of concrete shall be M 25 for all columns, beams, footing and slabs. The building shall be designed as per IS: 456, IS 800, IS 1893, IS 13920 (for ductility detailing)

The Fuel Oil Storage Tank foundations shall be either RCC raft or RCC Ring Beam system with compacted infill. The RCC raft /RCC ring beam shall be supported on virgin soil or pile foundation depending on the load bearing capacity of the soil. The tank bottom base plate shall

be supported on flexible compacted fill comprising 75mm thk Bitumen aggregate mix on top and compacted sand/ soil fill below, compacted in layers of 200mm to minimum 85% relative density as per IS:2720. The bitumen-aggregate mix shall consist of compact crushed stone, screenings, fine gravel, clean coarse sand(river sand) mixed in hot asphalt (8 to 10 percent by volume) and rolled or compacted. In the GA & detailing of foundation RCC ring wall/ beam it should be ensured that no bearing stress from tank superstructure is transmitted to the concrete surface.The top of flexible compact fill and top of RCC Circular wall shall be atleast 325mm above the surrounding ground surface for effective drainage.

The finished tank grade(Top surface of flexible compact fill) shall be crowned from its outer periphery to its centre at a slope of 1 in 100.

The Tank foundations shall be inside a RCC dyke wall enclosure. The entire area outside the tank foundations and within the surrounding RCC dyke walls shall be paved with concrete. The thickness of concrete paving shall be minimum 100mm.The single layer reinforcement in paving slab shall be min 10 Tor@200c/c. The area paving RCC slab shall be supported on 230mm thick Rubble soling with the internal voids filled with coarse sand. The height of the RCC dyke wall shall be evaluated based on the depth of Oil spillage for full oil volume of one storage Tank in addition to a free board of 300mm. Structural steel cross over ladder shall be provided (min 2 numbers) for each RCC wall dyke enclosure. Operating platforms wherever required as per functional requirement shall be provided.

The road tanker unloading platform shall be heavy duty RCC paving minimum 250 thk RCC slab resting on elevated compacted ground surface. A minimum slope of 1:250 shall be provided (in one direction) for the slab for Oil-Water Surface run-off to the peripheral drain. Expansion joints shall be provided in chess board fashion. RCC ramp shall be provided for approach of truck

The rail tanker unloading platform shall be based on the railway guidelines and statutory rules.

Fuel Oil Unloading Pump house shall be a covered building with RCC columns and Structural Steel Roof truss. 250mm thick external brick wall shall be provided with provisions for fire proof door, windows & rolling shutters. The basement RCC slab & RCC wall shall be designed as for uplift and external surcharge load as per the design criteria specified elsewhere. All fuel oil pump foundations shall be designed for both static & dynamic loading. The roof slab shall comprise 40th RCC slab over profiled permanent metal deck sheet (min 0.80mm thick) connected through shear anchor studs specified elsewhere in this specification.

The Oil-Water Separator RCC structure (pit) shall be designed as an underground structure. The sizing of the separator shall be based on the total surface run-off from the Fuel Oil Handling area and Hydraulic design for the oil separation. Surcharge load and ground water table up to ground surface shall be considered in addition to other functional loads for structural design of RCC wall for the separator pit.

Drainage trenches with proper bed slopes towards the oil-water separator pit shall be provided around the tank foundation. The entire area outside tank foundation shall have slope towards the drain trenches

Foundation for trestles and pedestal foundations, for supporting the pipes, shall be provided wherever required, at appropriate spacings. At pipe bends, necessary thrust resisting arrangement shall be provided.

The entire fuel Oil Handing area shall be fenced all round with minimum 1.50m high metal fencing with provision for gates at key locations.

Seismic design shall be carried out for the Fuel Oil Storage Tank foundation, Fuel Oil Unloading Pump House & the Oil water separator.

Architectural Features of Fuel Oil Handling Buildings:

Spaces for Pump Rooms, MCC Rooms, Control Rooms, etc shall be provided as per functional requirement. One Toilet shall be provided.

External finishing shall be of Premium Acrylic Smooth Paint with Silicone additives over suitable primer of water proof cement.

5.22.00 **O&M Workshop Building**

The O&M Workshop Building shall be a two bay fully covered building. The two bays shall comprise of workshop bay and office complex bay. The minimum span of workshop bay shall be 25m with RCC columns, structural steel roof truss and 40mm thick RCC roof slab supported on troughed permanently colour coated metal decking sheet and purlins. Roof water proofing shall be applied on roof slab as per details specified elsewhere in this specification. The Gantry girder for the EOT crane in the workshop building shall be structural steel plate girder supported on RCC corbels at column locations. The gantry girder shall be complete with chequered plate walkways (at both sides) and the cage ladder.

column free

The adjacent Office Complex bay shall have RCC superstructure. The minimum bay width shall be 6.50m.

Architectural Features:

The building shall be fully covered with brick wall masonry. provision of doors, windows & Rolling shutters shall be included based on architectural detailed drawing to be developed by the bidder. The rainwater down comers shall be provided at every column location and they shall be suitably connected to the building surface drain.

The minimum operating floor area for the workshop bay shall be 25mX110m out of which 450 sqm shall be earmarked for maintenance exclusively

The minimum head room of workshop bay shall be evaluated by the bidder based on approved EOT Crane Clearance diagram and crane rail level.

The office complex shall be 6.50mX110m in plan area. The office complex shall be made 2 storied for adequate space for operating personnel, MCC room, stores, Laboratories, Toilets, Conference room & Tool room. The floor to floor/ roof clear height shall be 4.50m.

5.23.00 Canteen

Salient Features: The Canteen Building shall be a RCC framed superstructure with large span roof system. The building shall be designed as per the latest guidelines of IS:456, IS 1893 & IS 13920(for seismic ductility requirement)

Architectural Features

This building shall be of RCC Frame structure& Autoclave Aerated Concrete Block masonry. The area of building shall be 1100 sq.m.

The building shall have entrance lobby, dining hall for staff, dining room for executives, pantry, kitchen, office, stores, wash areas, rest room for kitchen staff, toilets, etc.

External finish shall be of Premium Acrylic Smooth Paint with Silicone additives.

There shall be separate service road and entrance for supply of cooking materials and garbage disposal.

5.24.00 Fire Station Building

Salient Features: The Fire Station Building shall be a RCC framed superstructure. The building shall be designed as per the latest guidelines of IS:456, IS 1893 & IS 13920(for seismic ductility requirement)

Architectural Features

The number of fire tenders/ equipements shall be provided as given in Part-A Subsection-IIA-11

It shall be of RCC Frame structure& Brick masonry. The building shall be provided with area 600 sq m required to accommodate Fire tenders and fire personnel including Dy./Asst. Commandant's (Fire) office. ~~The number of fire tenders shall be provided as per CISF norms~~. One drill tower per station shall be provided. Facilities for the staff including Kitchen, Dinning Hall, Rest Rooms, Stores, First Aid Room shall be provided as applicable.

External finish shall be Premium Acrylic Smooth Paint with Silicone additives

5.25.00 Dozer Shed

Architectural Feature

This building shall be prefabricated steel framed structure with brick wall up to window sill height & prefabricated insulated double skin metal sheeting cladding above it. Roof of the building shall be prefabricated insulated double skin metal sheeting on steel roof truss.The building shall provide for Dozer shed space, Workshop space, Office Rooms, Stores, Toilet & Pantry as per functional requirement. Minimum size of the dozer shed shall be 500 Sq.m.

Metal side cladding shall be composed of different colour shades to match with the other buildings. External finish for brick walls shall be of Premium Acrylic Smooth Paint with Silicone additives.

5.26.00 Area Paving in Main Plant Block

RCC paving of minimum 150 mm thick with M25 grade concrete, over an under bed as specified herein shall be provided for areas mentioned below. RCC paving shall be designed as rigid reinforced concrete pavement for the crane/ vehicular/ equipment movement loads which the paving has to bear. The under bed for paving shall consist of preparation and consolidation of sub-grade to the required level, laying of stone soling of 200mm compacted thick for normal duty paving and 400mm compacted thick for heavy duty paving with 63 mm and down aggregate with interstices filled with selected moorum/ non-expansive soil followed by 75 mm thick 1:4:8 PCC (1 part cement, 4 parts sand and 8 parts stone aggregate) with 40 mm nominal size aggregate. For normal duty paving, reinforcement of the RCC paving shall consist of minimum 8mm dia bars @ 200 mm c / c in both directions at the centre of the slab. For heavy duty paving/ passage, reinforcement of the RCC paving shall consist of minimum 10mm dia bars @ 200 mm c / c in both directions at the centre of the slab.

Paving areas shall be provided with the metallic hardener floor finish as specified elsewhere in the specification.

Entire main plant area from chimney (edge of the storm water drain behind chimney) to transformer yard as enclosed within the peripheral roads of the main plant block and Air Cooled Condenser (ACC) Block enclosed between the peripheral roads shall be provided with paving.

All ground floor slab at 0.0m level inside the Main Plant building shall be provided with 50mm thick metallic hardener topping.

Passages shall be provided inside the Main plant block & ACC block connecting to the outer periphery road to have access to the various facilities/buildings. These passage areas shall be provided with heavy duty paving for movement of heavy vehicles. The top surface of the passages shall be finished with 50 mm thick metallic hardener topping. Heavy duty paving shall also be provided for the areas in the equipment lay down area in TG hall, complete Mill bunker building and handling areas for PA/FD/ID fans with 50 mm thick metallic hardener topping.

Ground floor area in the boiler shall be provided with normal duty paving and shall be finished with 50 mm thick metallic hardener topping.

Lightly loaded areas such as corridors below trestle and other areas in the Main plant block outside Main Plant building, Mill Bunker Building, Boiler area, ESP area, Transformer yard area & ACC block where no heavy traffic movement is envisaged shall be provided with interlocking concrete block paving with RCC concrete blocks of minimum M35 grade and minimum 80 mm thickness underlain by 200mm thick with 63 mm and down aggregate with interstices filled with selected moorum/ non-expansive soil.All other areas inside the Main plant block & ACC block shall be provided with normal duty paving without metallic hardener topping.

Para Deleted

~~In FGD area and in Denox system area, an area of 5 m width all around the buildings & facilities shall be provided with normal duty paving. This paving shall be beyond the extent of plinth protection. Further, heavy duty paving shall be provided for passages connecting the outer periphery road to have access to the various facilities/buildings.~~

~~In CPU area, 2.5 m wide normal duty paving around periphery of all sumps and underground tanks without metallic hardener shall be provided.~~

Open

Suitable drains shall be provided to dispose off storm water drain. The paving shall be provided with slope of 1:500 to dispose the surface water/wash water to the nearest drain. Drains shall be provided to dispose the floor wash water of ESP & Boiler to sump of suitable size.

Sewer lines (Cast Iron), interconnected by sewer manholes (RCC) at regular intervals (not exceeding 30 meter centre to centre) shall be provided to dispose off sewage from Main Power block to sewage pump house.

5.26.01 GROUND FLOOR SLAB OF BUILDINGS

In ground building including Main Plant Building, the ground floor slab shall consist of 150mm thick RCC M25 grade base slab over an under-bed a specified below. The under-bed of ground floor slab shall consist of 75 mm thick 1:4:8 PCC on stone soling of 200 mm compacted thick with 63mm and down aggregate with interstices filled with well graded selected sand/ moorum / non-expansive soil on compacted and dressed sub-grade. Reinforcement for the slab shall consist of minimum 8mm dia bars @200 mm c/c at top & bottom of the slab in both directions. However, at passages, unloading & maintenance bays, stone soling of minimum 400mm thick and minimum 10 mm dia bars @ 200 mm c/c at top and bottom in both directions shall be provided. Further, top surface of ground floor slabs shall be finished with 50mm thick metallic hardener topping.

5.27.00 Hydrogen Generation Plant Building

Salient Features

The Hydrogen Generation Plant Building shall be a RCC framed superstructure and its size shall be as per system requirement. This building falls under hazardous building category. The entire building campus shall be properly fenced to prevent unauthorised ingress or egress.

Architectural Features

This building shall be RCC Frame structure with brick masonry wall with provision for doors, windows, rolling shutters and exhaust fans.

Toilets & pantry, etc. shall be provided as per requirement. External finish shall be premium acrylic smooth exterior paint with silicon additives.

5.28.00 Conveyer's gallery

Architectural Features:

This shall be Steel frame structure with Single skin Metal Panel on sides and top roofing.

There shall be M.S. louvered windows and fixed glazing of polycarbonate sheets.

5.29.00 Not Used

5.30.00 Cooling Tower Switch Gear Room/Control Room

Architectural Features:

External Finish shall be Premium Acrylic Smooth Paint with Silicone additives.

5.31.00 Switchyard Control Room Building

Architectural Features:

External Finish shall be Premium Acrylic Smooth Paint with Silicone additives.

5.32.00 Water & Effluent Treatment Plant building

Architectural Features:

External Finish shall be Premium Acrylic Smooth Paint with Silicone additives.

5.33.00 Owner's Construction Office:

Pre-engineered One number of Owners Construction office is in Bidders Scope. This building should be single storyed. The building should be as per the tender drawing no. 9585-001-POC-A-002

The floor area for owner's construction office shall be 1400 Sqm

Pre-engineered building shall be of structural steel construction with metal roofing of approved profile and wall cladding should be of silica fibre board.

Pre-engineered building shall be complete in all respect as per tender drawing 9585-001-POC-A-002

5.34.00 **Not Used**

5.35.00 FQA LAB BUILDING

FQA Lab building shall be double storied R.C.C building with area 400 sq.m. It shall consists of spaces Offices & for Laboratories for Mechanical, Electrical, Civil& C&I. Toilets for Gents, ladies and handicap shall be provided as per NBC guidelines.

5.36.00 **CHP Workshop cum Office Building**

This shall be RCC framed structure having two storeys in office area and single storey (double height) in workshop area. Total floor area of the building shall be 900 Sq.m (700 Sq.m. Office area and 200 Sq.m. Workshop).

5.37.00 **SAFETY CENTRE**

~~Safety Centre Building shall be a R.C.C Building with area 200 sq. m. IT shall consist of Classrooms for 50 students, stores, office, staff room and toilets for ladies gents and physically handicapped persons.~~

~~The external finish shall be of Acrylic Smooth Exterior Paint with silicone additives.~~

This building shall be provided complete in all respect as per tender drawing 9585-001-POC-A-005.

5.38.00 **IT BUILDING**

IT Building shall be a R.C.C Building double storeyed with area 1200 sq.m. It shall be a completely air-conditioned building. IT Building shall be located inside plant boundary. It shall have spaces / facilities for IT Server Room, IT Communication Room, IT Operator Room, OFC Cables & Terminators FMS Room, Telephone Exchange Room, Battery Room, UPS Room, IT Store Room, IT Kiosk, three numbers cabin, conference hall, Testing and Repair Room, Executive hall, HOD Room with attached toilet, Secretariat for HOD, AHU, M.C.C Room, Pantry Toilets for Gents, Ladies and physically handicapped persons as per NBC norms, Staircases as per NBC norms. Space for installing V-SAT Antennae on Ground shall be provided. Minimum Floor to floor height shall be 4.50m. Minimum 70 mm floor finish margin shall be provided for laying metallic raceways.

IT building shall be a GRIHA rated building with minimum three star rating. The external finish shall be combination of Acrylic Smooth Exterior Paint with silicone additives and Aluminum Composite panel.

Clause No 5.39.00 to 5.39.10 Deleted

5.39.**00** ~~**Railway siding system (including in-plant yard) for Transportation of Coal, Lime, POL, Gypsum and fly ash.**~~

5.39.01 ~~**Review of Existing Railway Siding System**~~

~~Patratu TPS (325MW) is located bear Patratu town, Ramgarhdist, Jharkhand state. The plant is connected to Indian Railway network through approx. 3 km siding between plant and Patratu Railway station of Tori-Barkakhana section of East Central Railway. Coal for the project is being received through Indian Railway network.~~

	Review of existing railway siding system, to meet transportation of coal to plant for existing plant (325MW) and Proposed expansion in two stages (3x800MW+2x800MW) for railway siding system to meet transportation of coal and lime-stone to plant and evacuation of fly ash and gypsum from plant through Indian Railway system.
5.39.02	**SYSTEM DESIGN**
5.39.02.01	Consolidated traffic study for coal and non-coal movement to the project in view of receipt of coal through BOY, BOX, BOXNHA, BOY25, BOXNLW, BOXNHL, BOXN25, BOX32.5 BOXN and BOBR wagons (in line with RDSO G33, Rev 1 latest guidelines).
5.39.02.02	Study of additional facilities required inside plant & siding including the drainage system and other facilities crossing the proposed railway tracks. Study the requirement of locomotives for marshalling /shunting of rakes inside plant, recommended numbers and rating of locomotives required.
5.39.02.03	Optimize the track work and use of facilities to achieve designed unloading rate on a long term basis. Suggest procedures to deal with exigencies during shunting/marshalling. Study is also required for examining the possibility of engine on load scheme by elaborating the benefits of the scheme
5.39.02.04	The system should have capability to release the coal rakes received at the project within the free permissible time.
5.39.02.05	Arrangements for Communication system in consultation with Indian Railways, Provision of FOIS (Freight Operation Information System) or any other suitable system by Railways to know the rake status for Power station at any time.
5.39.02.06	Study the manpower requirement/ railway staff requirement to be posted at the cost of Patratu STPP and facilities to be provided. Study should elaborate the advantages and disadvantages on liberalized siding rules and possibility of handling of heavy haul rakes (longer rakes)
5.39.02.07	Assessment of electrical (OHE) and S & T requirement
5.39.02.08	Assessment of locos and workshop facilities, if any, as required.
5.39.02.09	Preparation of detailed system of working and station working rules. The report should contain the traffic study/turnaround time etc. The study may also indicate number of crossing stations/block sections/facilities required for Rail movement. Construction sequencing shall be planned without affecting the Coal transportation and movement of rail for existing 325 MW plant in operation.
5.39.03	Survey
5.39.03.01	Field reconnaissance for existing track from take-off point to plant entry and proposed augmentation. Final location survey forpicking up field data for preparation of index plans and longitudinal sections for detailing for bridges and culverts, opening and level crossings, over bridges and fly-overs/ FOB/ RURB/ RORB/viaduct for the rail track. Determination of road crossings, grade or grade separators, road diversions etc.
5.39.03.02	Establish correlation between Railway bench mark and Plant bench mark levels. The Coordinates of Railway siding also to be furnished as per the coordinates system adopted inplant General Layout Plan (GLP).

5.39.03.03	The assessment of additional land requirement (if any) by giving details such as private, govt., forest etc. and preparation of land requirement, if reqd, on Khasara map (including schedules & cadastral map) for land acquisition purpose for which may crop up during preparation of Engineering scale plan/ construction stage of the Railway siding. Identification of structures required demolition and its cost estimate and compensation (if any) to be paid.
5.39.03.04	Identification of culverts for drain, pipe crossings, manned and unmanned level crossings, bridges, FOB etc. No manned level crossing are to be provided on the MGR/ Railway siding. ROB/ RUB is to be provided for all road crossings. Crossing of Indian Railway tracks, if required, is to be done through a grade separator only (Rail over Rail Bridge).
5.39.03.05	NTPC Land boundary pillars for the Railway siding corridor (minimum size 200mmx200mmx900mm long @ 100m c/c)) are to be provided after construction and commissioning of the Railway siding system. The location of the pillars is to be marked in the as built drawings
5.39.04	**Detailed Project Report**
5.39.04.01	Finalization and submission of Detailed Project Report based on final survey results, system design, manpower requirement etc. The detailed project report shall identify the cost estimates inclusive of the work executed through Railways as deposit works and the time schedule for execution of the works.
5.39.05	DETAILED ENGINEERING This covers in general the electrified and non-electrified track, bridges, ROB/RUB/RORB/Fly overs, viaduct, culverts, buildings, control rooms, workshops etc. this will include the following:-
5.39.05.01	Preparation and submission of detailed technical specifications with applicable tender drawings, BOQ, cost estimates with unit rates for each and every item of civil work in tender schedules covering all types of bridge/ culverts, banks and cutting, drainage works, cable trenches, goomties, control rooms, station buildings, track and permanent way including rails, sleepers, points and crossings, fish plates and other track fittings etc.
5.39.05.02	Preparation of schedule of quantities of materials for which advance procurement action will be necessary viz. Cement, sleepers, track fittings, rails, ballast, etc. schedule of quantities for works to be done through deposit work shall also be prepared and submitted separately.
5.39.05.03	Preparation and submission of detailed design and construction drawings for each and every item of civil work as elaborated above including geo-technical investigation as required for detailed design of bridges, culverts, embankments etc. All clarifications/ queries on the construction drawings during execution including any revision thereof shall be furnished.
5.39.05.04	Preparation of detailed design and drawings (and obtaining the approval of Railways and other concerned authorities) for the following. a. P-way b. Yard Modifications c. Formation of bank and cuttings d. Bridges, culverts, crossovers etc. e. ROBs /RUBs, buildings, workshops etc. f. All civil and structural works pertaining to OHE and S&T works.
5.39.05.05	For design of bridges following shall be considered:

	i) The rainfall storm and catchment area considered for determining flood discharge and criteria for fixing waterway. The expected afflux and its impact on nearby habitated areas should also be examined. ii) Calculations of scour depth for foundation design of bridges. iii) Upstream, downstream and bed protection design and criteria, if any.
5.39.06	SIGNALLING AND TELECOMMUNICATIONS AND OHE WORKS
5.39.06.01	Preparation of detailed system design for signaling, telecommunication works and OHE works (if required). All portions pertaining to Railway Siding shall be got approved by Railways.
5.39.06.02	Preparation and issue of technical specifications, BOQ, tender drawings (signal plans, panel diagrams and selection tables for signaling works and as required for telecommunication and OHE works) and cost estimates.
5.39.06.03	Study of existing S&T system of the serving station and suggest modifications required (if any) in the existing system.
5.39.06.04	Drawings for layout of control room/ cabins including equipment & cable layout and foundations related to the installation of S&T works.
5.39.06.04	Submission of list of spares, tools & plants and maintenance schedule.
5.39.06.05	Possibility of use of solid state signaling with LED may be studied.
5.39.06.06	In addition to tele-communication provision of wireless communication between control room, loco drivers, Railway station, operation I/c is also required to be explored.
5.39.07	**Construction of Railway siding system**
5.39.07.01	Construction of the Railway siding system is to be undertaken as per Railways guidelines through railway approved agencies/ Consultants.
5.39.07.02	Construction of the complete railway siding system including in-plant rail yard for stage I (3x800MW) (including siding from serving station to plant, Augmentation of serving station, in plant rail yard as per Railways requirement, ROB, RUB, bridges/culverts, viaduct all necessary drainage arrangements for entire railway siding etc) including S&T (Signaling & Telecommunication), OHE (Overhead Electrification) and other associated works such as panel buildings, TXR building etc as per railways requirement. Construction of Rail track for stage II facilities is not envisaged in this contract. Adequate provisions for Stage II facilities shall be provided in the facilities being provided by the bidder. Bidder is required to provide necessary take-off with isolation arrangement for Stage II tracks (Turnout with point machine plus minimum one rail length track plus isolation including OHE and S&T) for connection at a later stage without affecting traffic of stage I units. Further, the panel buildings/ S&T system should be for the S&T requirement of Stage I & Stage II. Scope also includes up gradation of the existing railway siding system, including the serving station(s) as per the requirement of Indian Railways.
5.39.07.03	Facilities of in-motion Weigh Bridge (150T capacity) for weighment of all inward & outward rakes is in the scope of bidder. In-motion weigh bridge to be provided as per RDSO specifications. Two weigh bridges (complete with building etc) each for weighment of loaded

	and empty rakes are to be provided. The location of the weigh bridge is to be finalized by the bidder.
5.39.07.04	Level crossing, whether manned or unmanned, is not permitted in the siding from serving station to plant boundary. All road crossings outside plant boundary is to be provided with Grade separator i.e., Road over bridge (ROB) or Road under bridge (RUB). Existing level crossing is to be changed with Grade separator i.e., Road over bridge (ROB) or Road under bridge (RUB). For road crossings inside plant boundary, ROB/ RUB is to be provided at the locations indicated in the General Layout plan issued to the bidders. Suitable drainage arrangements with connections upto final disposal points are to be provided for the RUB to avoid water-logging.
5.39.07.05	Loco shed with all facilities required for carrying out maintenance as per half yearly schedule as per Railway standards. However, the following minimum facilities are to be provided: a. Loco shed 30m x 20m with inspection pit of 25 long & EOT crane 40T x 10T-20m span. b. Double storied office building of 480 sqm area for office/ store for loco maintenance. c. Fuelling facility/ station – 45KL capacity including filling arrangement. d. Washing apron 25m long is to be constructed as per Railway standards with oil separator pit.
5.39.07.06	Construction sequencing shall be planned without affecting the Coal transportation and movement of rail for existing 325 MW plant in operation.
5.39.08	**Facilitation in Land Acquisition /Procurement /Leasing of land**
5.39.08.01	Facilitation in Land Acquisition /Procurement /Leasing of land as necessary, for and on behalf of PVUNL, for construction of the siding. Bidder shall coordinate with local revenue/ State Govt authorities, local panchayat and PVUNL project authorities for acquisition/ leasing of land, as necessary (for construction of siding) on 'willing buyer willing seller' basis. Bidder shall be responsible for finalising the land plans/ land schedules, identification of rightful ownership documents/ details, negotiating the land cost/ compensation in association with revenue/ state Authorities/ PVUNL, submitting applications in required format, disbursement of land costs/ compensation to rightful owners in form as advised/ agreed by State Authorities (including facilitating opening of bank accounts of beneficiaries), completion of documentation for transfer titles/ mutation of land to PVUNL, taking physical possession of land including vacation of land oustees and any other activity required for taking possession of land & final handover of land to PVUNL. The payment of land cost cost/ compensation as per advice & agreement with land owners/ State Authorities shall be paid by PVUNL.
5.39.09	General requirements
5.39.09.01	Preparation and submission of Detailed Project Report incorporating above details to obtain approval from NTPC/Railways. The report should include recommendation clearly based on a techno -economic study bringing out tangible/intangible benefit to NTPC on the subject.
5.39.09.02	Complete co-ordination and liaison with Railway, state/central govt. including the approval of the scheme from Railways and other agencies as required.

5.39.09.03	Co-ordination with NH/state authorities/ for ROB, RUB and obtaining their clearances.
5.39.09.04	Traffic study, Staffing study for O&M, railway staff to be deployed at the proposed TPS at NTPC cost.
5.39.09.05	All coordination with any other agency whose facilities have interface with the Railway siding/coal transportation system.
5.39.09.06	The consultant appointed for the DPR, Detailed Engineering and Construction should have valid enlistment with the concerned Railways till the validity of this contract.
5.39.09.07	The geo technical investigations shall be done strictly as per RDSO/ Railway's guidelines. Copies of RDSO/railway's guidelines (latest revisions) required for the detailed Engg work shall be made available to NTPC
5.39.09.08	The Bidder shall be shall be responsible to provide all necessary services, documents and technical information consisting of and relating to detailed engineering, procurement, construction, and supervision and commissioning activities of the PROJECT as applicable in accordance with Standard Engineering Practice/Railways/RDSO guidelines. Documents shall also include all relevant RDSO drawings required for inspection and execution of the job. 5 (five) sets of all relevant RDSO drawings OHE, S&T manuals and IRPWM etc shall be handed over to NTPC at the commissioning of the Project.
5.39.09.09	The Bidder would be required to supervise the operations for a period of 12 months beyond the successful commissioning of the system for stabilizing of the system and resolution of problems/ issues arising out of the same including coordination with concerned agency/ Railways.
5.39.10	**Deliverables** The Bidder shall submit, the following documents to NTPC: i. Eight (8) copies of draft Detailed Project Report including drawings and land plan assessment. ii. Twelve copies (12) of Final Detailed Project Report & ESP along with the drawings. iii. Construction drawings & As-built drawings: 8 sets iv. 5 sets of reproducible copy (CD ROM) of Draft DPR, final Detailed Project Report along with the drawings, As built drawings. Note: The above requirement is exclusive of submissions required for clearance/approvals from railways/ State/ Central Govt agencies/ NH.
5.40.00	**AIR COOLED CONDENSER SUPPORTING STRUCTURE** The bidder shall have the option to design the air cooled condenser (ACC) supporting structure either with structural steel framed superstructure adequately braced in vertical planes in both the orthogonal directions or **with RCC pylon structure.** The general arrangement & details of structural steel columns, beams, bracings or **RCC structure** shall be as per the bidders ACC structure design and detailed engineering scheme. In case of steel supporting structure, the bottom level of base plates of columns shall be 1.20 M below the finished floor level of ground floor of Main Power House. The RCC pedestals supporting the column base plates shall be extended in order to provide RCC encasement to the structural steel columns up to at least 350 mm above the top of the paving RCC slab.

In case Bidder adopts RCC pylon for Air cooled condenser structures, casting of the same shall be done using slipform shuttering. For construction of RCC pylons, bidder should engage an agency who has experience in construction of RCC shell-like structures like chimney/ silo/ pylon using slipform equipment.

Design Concept:

ACC supporting super-structure shall be designed by the Bidder based on working stress method for (i) structural steel as per IS 800 & for (ii) RCC pylons as per IS 4998 & CICIND model code and RCC foundations as per IS : 456.

5.41.00 **Balance Buildings**

For all other buildings mentioned in the scope of work but requirement not furnished in this chapter, the Bidder shall develop the details of such buildings based on the functional and statutory requirements. 5.42.00 Flue Gas De-sulphurization System attached as Annexure-1

6.00.00 **DESIGN CRITERIA**

6.01.01 **General**

The design criteria given herein is applicable for all structures and buildings including Main Plant buildings, Control building, office/service building, Mill and Bunker building, Coal Conveyor Galleries/Trestles, Transfer Points, Track hopper, Tunnel, Pent house, Stacker-reclaimer supporting structure, Crusher house, Chimney, Cooling towers, Fuel Oil Handling Plant, Light Diesel Oil Handling System, Pump Houses, Compressor house, D.G. Set building, switch gear and other miscellaneous buildings, Culverts, Bridges, Water retaining/carrying structures, Boiler/ESP supporting structures, Switchyard structures, Ash Silos, Roads, Drains, Sewers, Cables and pipe trestles, all ash handling facilities and various other works included in the scope of the bidder. facilities of FGD system

6.01.02 Structures shall be designed for the most critical combinations of dead loads, imposed loads, equipment loads, crane loads, piping loads (static, friction and dynamic), earth pressure & surcharge loads, Hydrostatic & Hydrodynamic loads, wind loads, seismic loads and temperature loads. In addition, Erection loads, loads and forces developed due to differential settlement shall also be considered.

6.01.03 i) All the buildings shall have framed super structure. If the superstructure of building is a steel structure, the framed superstructure shall be moment resisting sway frame in the lateral direction and axially braced in the orthogonal direction. Columns having depth of 400mm & less shall have bracing in single plane and at the centerline of column. For columns having depth of 500mm & above, the longitudinal bracings shall comprise a pair of members (spaced) with spacing equal to the column depth. Only where axial bracing to one vertical plane is to be waived due to functional requirement, columns in that vertical plane may be allowed to undergo biaxial bending. Beam column joints shall be detailed as per seismic resistant joint with adequate ductility.

All 2-legged structural steel trestles shall be completely braced in the vertical plane. All 4-legged structural steel trestles shall be completely braced in all four vertical planes. In addition, specified horizontal planes shall be completely braced to provide stiffness against torsional sway.

If the superstructure is RCC structure, the superstructure shall be moment resisting sway frame in both orthogonal direction and all the members shall be designed for biaxial bending. Design of RCC structures shall be done as per IS 456 Detailing for ductility shall be followed as per guidelines of IS13920 to be effective against seismic load. Design of liquid retaining structures shall be done as per IS 3370

ii) The Main Plant building, Bunker building, transfer towers, conveyor galleries and trestles, crusher house, boiler, ESP Control Building, ESP supporting structures, including inlet and exhaust duct support structures, Compressor House, Pipe cable Gallery shall have structural steel framed super structure.

iii) All other buildings may have either RCC or structural steel framework.

iv) All buildings having RCC framing shall have masonry cladding of minimum one masonry unit thickness (not less than 225 mm.) on exterior face.

v) Cladding detail for specific building shall be provided by the bidder as per final recommendation for type of buildings furnished to the bidder.

6.02.00 **Loading**

6.02.01 **Dead loads**

Dead loads shall include the weight of structure complete with finishes, fixtures and partitions and shall be taken as per IS: 875 (Part-I)

6.02.02 **Imposed loads**

Imposed loads in different areas shall include live loads, erection, operation and maintenance loads. Equipment loads (which constitute all loads of equipment to be supported on the building frame) are not included in the imposed loads furnished below and shall be considered in addition to imposed loads.

For consideration of imposed loads on structures, IS:875 (Part-2) "Code of practice for design loads (other than earthquake) for buildings and structures" shall be followed. The following minimum imposed loads as indicated for some of the important areas shall however be considered for the design. If actual expected load is more than the specified minimum load, then actual load is to be considered.

Sl.No.	Location	Imposed Loads (T/Sq.m.)
A)	Turbine Building	
i)	Ground floor (general)	2.50
ii)	Ground floor (heavy equipment storage area)	5.00
iii)	Mezzanine floor	1.00
iv)	Operating floor	
	a) Rotor Removal area	5.00
	b) Equipment lay-down area	3.50
	c) Other areas (corridors, etc.)	1.50
v)	Gratings, chequered floors, walkways, platforms, stairs, etc.,	0.50
vi)	Roof (Where no equipment is located)	0.15
vii)	Roof (where equipment are	

located) 0.50

B)	Deaerator and Heater Bay		
	i)	H.P/L.P. heater floor	1.00
	ii)	Deaerator floor 1.00	
	iii)	Cable gallery (In addition to this, actual cable load shall be considered)	0.50
	iv)	MCC, switchgear and Control building floors	1.00
	v)	Roof (Where no equipment are located)	0.15
		(Where equipment are located)	0.5
	vi)	A.H.U Room, Battery Room, Air Washer Room	1.0
C)	Mill and Bunker Bay		
	i)	Ground floor	2.5
	ii)	Feeder floor	0.50
	iii)	Tripper floor	0.50
	iv)	Roof	0.15 (Where no equipment are located) 0.50 (Where equipment are located) 0.075 (For Inaccessible roof)
D)	Pump Houses		
	Operating floor		1.50
E)	Maintenance bay (CWPH & RWPH)		3.0

F) Underground Structures such as Channels, Sumps, Underground Pump House, Tanks, Trenches, Reservoirs, C.W. ducts etc.

In addition to earth pressure and ground water pressure, the surcharge load of 2T/sq.m. shall also be considered for design of all underground structures.

G) Road Culverts/Bridges and its allied structures including RCC Pipe Crossings and Road Crossing of Trenches.

Design for class 'AA' loading (wheeled and tracked both) and checked for class 'A' loading as per IRC Standard.

H) Covers for Channels/trenches — 0.40 (General) or central point load of 75 kg whichever is higher

		As per IRC Standard (at road crossings for vehicular traffic)
I)	Railway Supporting Structures, Rail Culverts	As per Railway 'Bridge Rules'
J)	Boiler/ ESP Support Structures	
	i. Operating Floors	1.00
	ii. Separator Floor	1.00
	iii. Elevator Machine Room	1.00
	iv. Maintenance Platforms	1.00
	v. Equipment Laydown Loads	As per Equipment supplier or 1.00 whichever is more.
	vi. Lift Structure	As per Equipment supplier with 100% impact factor
K)	Conveyor Galleries	In addition to the live loads, loads due to cable trays, fire fighting / service water pipes shall also be considered @125Kg/m(minimum) on each of the longitudinal girder. Roof-truss members are to be checked for supporting fire fighting pipes/ Service water pipes. Tentative locations and diameter for pipes
L)	General (Unless Specified Otherwise)	
	i) Stairs, Landings and Balconies	0.50
	ii) Toilets	0.20
iii)	Chequered plates, grating floors, etc.,	0.50
	iv) RCC floors (General)	0.50
	v) a) Flat Roofs (where no equipment are located)	0.15
	b) Flat Roofs (where equipment are located)	0.50
	c) Inaccessible roof	0.075
	vi) Inclined Roofs	As per IS : 875 (Part-II)
	vii) Dust load on roof	Equivalent to 0.30 M of ash deposit
	viii) Walkways (General)	0.50

	ix)	Walkways of conveyor galleries, DM & PT	0.30
	x)	Floor of control room of switchyard control building	1.00
	xi)	Cable and pipe trestles addition, friction loads	0.40 for walkway and in as applicable

Notes:

a) If erection load is higher than the specified imposed loads on any floor or part thereof, then the erection loads are to be considered for the design.

b) Additional load for cable, piping/ducting, shall be considered as applicable. For any other structures, the loads specified for those structures elsewhere in the specification shall be followed.

c) Load of 1 Tonne/Sq.m shall be considered on floors of all Switchgear room, Cable Vaults including those for Switchgear and Cables, supply of which is not included in Bidder's scope. Load for cable trays shall be 50kg/m/tray – for 300mm wide tray and 75kg/m/tray – for 600mm wide.

d) Load for Indoor (Dry Type) transformer, to be supplied by others and to be installed in LT Switchgear room (Bidder's scope), shall be 8.0 Tonne.

6.02.03 **Equipment, piping and associated loads**

Equipment loads shall be considered over and above the imposed loads. Equipment loads shall be considered as given by equipment supplier.

6.02.04 **Crane load**

For crane loads, an impact factor of 25% and lateral crane surge of 10% (of lifted weight + trolley weight) shall be considered in the analysis of frame according to the provisions of IS:875. The longitudinal crane surge shall be 5% of the static wheel load. Longitudinal surge and lateral surge shall not be considered to act simultaneously.

6.02.05 **Seismic load**

For design of all structures, the site specific seismic spectrum as attached in Annexure-(e) shall be followed.

6.02.06 **Wind load**

For design of all structures, the wind loads shall be taken as per the site specific wind data specified in Annexure–(d) of this specification.

6.02.07 **Temperature load**

For temperature loading, the total temperature variation shall be considered as 2/3 of the average maximum annual variation in temperature. The average maximum annual variation in temperature for this purpose shall be taken as the difference between the mean of the daily minimum ambient temperature during the coldest month of the year and mean of daily maximum ambient temperature during the hottest month of the year. The structure shall be designed to withstand stresses due to 50% of the total temperature variation.

Suitable expansion joints shall be provided in the longitudinal direction wherever necessary with provision of twin columns. The maximum distance of the expansion joint shall be as per the provisions of IS: 800 and IS: 456 for steel and concrete structures respectively.

6.02.08 **Differential settlement Loads**

Structures shall be designed considering an additional load on account of differential settlement of 1 in 1000 between any two adjacent columns, subject to a maximum differential settlement of 8 mm in case of foundations resting on soils & 4mm in case of foundations resting on rock/ pile.
These differential settlement loads shall be taken into consideration for design of footings & structures of Main Power House & Control Tower, Boiler & Mill Bunker, ESP supporting structure & ESP Control room only. Further, adjacent columns interconnected with vertical bracings are preferably be provided with combined footing. In such cases, where rigid combined foundations are provided below braced columns, differential settlement between those columns needs not be considered. Moreover, when rigid raft is provided, the differential settlement amongst the columns supported on the rigid raft need not be considered. However, the differential settlement between the raft and the adjacent column footing of the same structure are to be considered. In the structural analysis for calculating loads due to differential settlement, following approach may be considered: All the alternate columns in structure shall be applied downward differential settlement as described above and analyzed at a time. The resultant forces/ reactions shall be considered with reversible effects along with other load cases for design of structures and footings.

6.02.09	**Additional Loads** Following Minimum additional Loads shall be considered in the design of Steam generator structures, Mill & bunker buildings, Coal handling Transfer points and Trestlesand ESP structure. (a) Cantilever Loads of not less than 2000 Kg / M at a distance of 1200 mm from the external face of the columns, on both sides of the ESP, for Cable trays and Walkways. (b) Cantilever Loads of not less than 500 Kg / M at a distance of 1200 mm from the external face of the columns, on both sides of the Steam Generator, for Cable trays and Walkways. (c) Cantilever Loads of not less than 2000 Kg / M at a distance of 2500 mm from the external face of the Mill & Bunker Building columns, CHP transfer point columns/ VGTU columns & conveyor gallery trestles (on one side) for Cable trays and Walkways. (d) Dry Fly Ash Piping Loads. (e) Ash Water Piping Loads. (f) Supply Air and Instrument Air Piping. (g) Service Water Piping (h) Loads associated with Coal Handling Plant equipment
6.2.10	**Air Cooled Condenser support structures shall be designed for:** i) Live/Imposed loads. ii) Dead load iii) Static and dynamic loads of piping, movable equipment and maintenance parts. iv) Loads from cable trays and walkways supported on columns. v) Seismic and wind loads as specified elsewhere in the specifications. vi) Temperature variation as specified elsewhere in the specification. vii) The loads listed above indicate the minimum requirements.
6.03.00	**Civil Design Concepts**
6.03.01	Individual members of the frame shall be designed for the worst combination of forces such as bending moment, axial force, shear force, torsion, etc.,
6.03.02	The different load combinations shall be taken as per IS: 875 (Part-5) and other relevant IS Codes. a) Wind and seismic forces shall not be considered to act simultaneously. b) For the design of main plant structures during seismic condition, the deaerator feed water tank shall be considered full upto operating level. However, for other load combinations, deaerator feed water tank in flooded condition shall be considered. c) 'Lifted load' of crane shall not be considered during seismic condition. d) In case two cranes are provided and tandem operation is not envisaged, the load shall be taken as one crane fully loaded and second crane without lifted load but standing idle adjacent to first crane.

e) In case two cranes are provided and tandem operation is envisaged then the crane wheel loads shall be taken as both the cranes fully loaded to capacity and travelling side by side althrough the Main Power House building length.

f) Permissible stresses for different load combinations shall be taken as per relevant IS and IRS codes.

g) For the design of pipe/cable supporting structure, the soil weight shall be considered as backfilled up to grade level for the condition of pipe running full/cables in position.

h) Frictional forces between the pipes and supporting structure in longitudinal direction need not be considered along with seismic or wind forces.

i) Paving in crane corridor shall be designed for the maximum load due to movement of crane.

j) In TG bay at crane rail level, chequered plate walkway with handrails shall be provided for entire column sectional depth for full length of the building. Walkway width clearance from the face of the column to the edge of the crane shall be as specified elsewhere in the specification.

k) For checking against uplift / tension case, 90% of Dead Loads with no Imposed Loads shall be considered along with other Loads.

l) The Structures shall be Designed for most unfavorable Combination of Dead Loads, Imposed Loads, Equipment Loads, Piping / Cables / Ducts Loads, Wind / Seismic Loads, Temperature Loads, Ash Loads, and other applicable Loads without exceeding the Permissible Stresses

m) In all Loading Combinations, the Loads that have reduction effect on design condition shall not be taken into account in the Combination concerned.

n) Where Wind is the main Load acting on the Structure, no increase in Stresses is to be considered for Design of Structures and Foundation Bolts.

o) In all Load Combinations, differential settlement loads (with reversible effects) are to be considered.

6.03.03 Design of steel structures shall be done by the Working stress method. Design shall be as per provisions of IS:800:1984 and other relevant IS standards. For design of coal bins and loading hopper IS:9178 (part I to III) shall be followed.

6.03.04 Shop Connections will be all welded type and field connections will shall be bolted. Field permanent bolts wherever provided will be high tensile bolts of property class 8.8(min) as per 1367 for all major connections. However, nominal connections in the field like purlins, stairs, wall beams will be done by means of M.S. black bolts of grade 4.6 conforming to IS-1367. The bolted joints will be designed for friction grip or bearing type. For friction grip type connections, bolts will be tightened to develop the required pretension during their installation.

For bolted Connection, IS 4000, IS: 3757, IS: 6623 and IS: 6649 shall be followed. IS 814, IS 816, IS: 1024, IS 4353 and IS: 9595 shall be followed for welding of structures.

6.03.05 For calculation of coal load on moving conveyor, a multiplication factor of 1.6 shall be used to take care of inertia force, casual over burden and impact factor, etc. Thus coal load per unit length of each moving conveyor shall be

$$\frac{1.6 \times (\text{rated capacity of conveyor system})}{\text{Conveyor speed}} \times \frac{1100}{800}$$

6.03.06 a) Conveyor gallery structure and trestles shall be designed considering both conveyors operating simultaneously

b) Dynamic analysis of conveyor galleries and conveyor supporting system shall be carried out for spans greater than 25 m.

c) All structures close to railway line shall have clearances conforming to Railway norms.

6.03.07 Horizontal Deflection criteria

The maximum Horizontal Deflection for various structures shall not exceed and be limited to the following:

Sl. No.	Description	Maximum value of
1.	For Trestles and transfer points (Transverse deflection at Conveyor gallery supporting level)	Height/1000 (For Wind load by Peak Wind Speed Method / Seismic Load)
2.	For Main Power House (Turbine Bldg), ESP Control Building, Compressor House, Service Building, Workshop Building, Balance of Plant Buildings and all other buildings envisaged in this specification	Height /325
3.	Vertical Metal Sheeting in Cladding	Span/250

However, the maximum deflection of Grating / Chequered Plate Shall be limited to 6mm.

Note: Stresses under wind load condition for all structures shall be checked for the higher of forces obtained from Gust Factor Method and Peak Wind Speed Method.

For deflection check on TP's/ Trestles Wind Load by Peak Wind Speed Method along with load due to Belt Tension and Dead Loads shall be considered.

6.03.08 a) Dispersion of load in any direction through soil shall be as per IS: 8009 (relevant part).

b) Dispersion of load through concrete shall be considered at an angle of 45 degrees with horizontal from the edge of contact area.

6.03.09 a) Permissible deflection (unless specified otherwise in this specification) for latticed framework and beams of floors other than drive floor shall be span/325.

b) The allowable deflection for beams directly supporting drive machinery and equipmentshall be restricted to span/500 unless specified otherwise in this specification.

c) The deflection for manually operated cranes & monorail supporting beams shall not exceed span/500.

For electric overhead cranes :

1) upto 50 t capacity : span/750

2) over 50 t capacity : span/1000

d) The vertical deflection of beams supporting LP Heater, HP Heater and Deaerator shall be limited to Span/500.

e) The vertical deflection of metal deck sheet for floor shall be limited to span/250.

f) Permissible deflection for all purlins, cladding runners, roofing/cladding sheets and grating / chequered plates shall be span/250. However, the maximum vertical deflection of Grating/ Chequered plate shall be limited to 6 mm.

6.03.10 Transverse coal pressure on Bunker/Silo/Hopper walls shall be calculated as per IS: 9178. The Coal Bunker/Silo/Hopper shall be designed for the following conditions

i) The Bunker/Silo/Hopper is full up to its full capacity with top surface nearly horizontal.

ii) The Bunker/Silo/Hopper is partially empty with the top surface of coal at an angle of repose of 37 degrees.

6.03.11 Design criteria for ash silo

1. The pressure due to ash filling on the side wall and the bottom portion of ash bins/silos shall be taken as the maximum of (a) static pressure determined in accordance with the Jansen's formula multiplied by an impact factor of 1.4 and (b) pressure determined as per Walker's formula for static as well as dynamic conditions. The silo shall be designed for the following conditions:

   (a) The silo is full up to its full height / capacity

   (b) The silo is partially empty with top surface of ash, at an angle of repose less than 30 degrees.

2. The following loads are to be considered for design.

   a) Density of bottom ash to be considered for volume calculation shall be 650 kg./cu.m.

   b) Density of bottom ash to be considered for load calculation shall be 1600 kg/cu.m.

   c) Density of fly ash to be considered for volume calculation shall be 750 kg/cu.m.

   d) Density of fly ash to be considered for load calculation shall be 1600 kg./cu.m.

   e) Density of dry fly ash, to be considered for the design of supporting structures for dry fly ash conveying pipes, shall be taken as 1000 kg/cum. The pipe shall be considered full with dry fly ash.

3. Other requirements are as follows:

   a) Independent supporting structure shall be provided for each silo.

   b) The joint between the wall and roof of the silo shall be properly sealed by welding or by any other approved means.

   c) Operating platform covering total plan areawise in silo structure made of grating shall be provided below the hopper outlet.

   d) The bracing system shall be provided in such a way that the trucks and closed tankers can have a clear passage to approach the underside of the silos for unloading dry ash from the silos.

4. Trestles supporting ash pipes shall be so proportioned that the transverse deflection of trestles due to wind/seismic load shall not exceed trestle height/325.

5. The corrosion allowance for design of Silo, Buffer Hopper, Bottom ash hopper, tanks etc. shall be considered as per IS:9178 considering structure exposed to atmosphere. The corrosion allowance shall be provided in addition to the requirement of minimum thickness of steel plate as per IS:9178.

6.03.12 Coal Bunker (inside Mill Bunker Building) shall be of MS while the hopper shall be of MS with stainless steel (grade SS 304) lining. The minimum thickness of MS plate and SS lining in hopper portion shall be as specified in the design concept of Mill Bunker Building in the previous chapter. Pre-formed flexible open ended bellow strap of neoprene is to be provided between top of bunker and bottom of tripper floor to avoid coal dust leakage / escape. The bellow strap shall be of minimum 200 mm wide under un-stretched condition and shall be of minimum 2mm thick.

The hopper angle with the horizontal plane be as specified in the previous chapter.

6.03.13 The live storage capacity of each coal bunker shall be greater of the following:

a) Total 10 hours coal requirement of the boiler for BMCR duty with worst coal firing, equally distributed over the number of bunkers (i.e. the coal mills) required in service for this duty condition as specified elsewhere.

b) Total 10 hours coal requirement of the boiler for BMCR duty with design coal firing, equally distributed over the number of bunkers (i.e. the coal mills) required in service for this duty condition as specified elsewhere.

c) Total 10 hours coal requirement of the boiler for TMCR duty with worst coal firing, equally distributed over the number of bunkers (i.e. the coal mills) required to be in service for this duty condition as specified elsewhere.

6.03.14 For all capacity (volume) calculation and structural design (load calculation) unit weight of coal shall be assumed as 800 Kg/cu.m. and 1100 Kg/cu.m respectively.

6.03.15 Design pressure on coal bunker/hopper walls shall take into account all possible flow regimes (core flow, mass flow, etc.), and different aeration regimes (radial, diametrical, radial and core, impulsive, etc).

6.03.16 a) The design and construction of RCC structures shall be carried out as per IS: 456. Working stress method shall be adopted for the design wherever specifically mentioned in this specification.

b) For design and construction of steel-concrete composite members, IS: 11384 shall be followed.

c) For reinforcement detailing, IS: 5525 and SP: 34 shall be followed.

d) Two layers of reinforcement (on both inner and outer faces) shall be provided for RCC wall sections having thickness 150 mm or more.

6.03.17 Not Used

6.03.18 Not Used

6.03.19 Not Used

6.03.20 Not Used

6.03.21 **a) Design of Foundation for TG, TDBFP, MDBFP & Fan foundations**

(i) Scope of Work for Bidder

The scope of work for the design shall consist of the following:

- Finalization of the general arrangement layout and levels of the foundation for TG, TDBFP, MDBFP & FAN foundations based on the equipment layout keeping in view the layout constraint and limitations of available space.
- Submission of design criteria and loading data of the equipment foundations.
- Analysis of the top deck, design and detailing of the reinforcement and finalization of the spring arrangement.

- Submission of all design calculation, all loading drawings, general arrangement drawings, embedment drawings, spring arrangement drawings and reinforcement drawings for the foundations under the scope for the approval of the Owner. Carrying out revisions / alterations based on the comments of the Owner. In addition to hard copies, the final soft copy of all drawings (in Autocad and pdf format) and documents shall also to be submitted.
- Submission of construction methodology / casting sequence and special requirements (if any) for the top of deck.

Structural Arrangement of foundations for various machine foundations like TG, TDBFP & MDBFP & FAN and Coal Mill shall be as specified in Chapter-5 of this specification.

(ii) Analysis for the foundation

For the foundations of the all equipments, details static and dynamic analysis shall be done. The static analysis shall include all operating condition, load cases and abnormal loads like short circuit, loss of blades & unbalance and seismic forces as per IS:1893. The dynamic analysis shall consist of free vibration analysis and forced vibration analysis. A minimum fatigue factor of 2.0 shall be considered for dynamic forces.

The vibration amplitudes shall be calculated at the machine bearing locations and at any other points of interest by a forced response analysis. The unbalance forces used for this analysis shall correspond to the balance quality grade of the machine as per ISO 1940 or the unbalance forces as provided by the machine manufacturer which ever is higher. It shall be ensured that the calculated amplitudes do not exceed the limits specified by the machine manufacturer and relevant Standards such as ISO 10816.

Bidder to consider the acceleration at the top of the deck for the design of supporting / fixing arrangement of machine.

(iii) Design criteria for steel helical springs and viscous dampers

The isolation efficiency for steel helical springs and viscous dampers shall be at least 90%. The ratio of actual spring supported weight to the nominal spring capacity shall not exceed 0.80. At least 5% to 10% of critical damping shall be provided in the form of viscous dampers.

(iv) Grade of Concrete and reinforcement

Grade of concrete for Top deck shall be minimum M35 conforming to IS:456-2000. The grade of reinforcement for Top deck shall be Fe500 (TMT) conforming to IS:1786.

(v) Reinforcement Design

Working stress method as per IS: 456-2000 shall be used for reinforcement design. The design shall be done for the worst load combination. Minimum reinforcement shall be provided as per IS:456-2000 and IS:2974 (Part-III), if the calculated reinforcement is less than the minimum.

For TG Raft/ Pilecap, minimum percentage of reinforcement at top and bottom faces of foundation shall be same as that stipulated for beam as per IS:456.

Block Foundations:

a) Block foundation resting on soil shall be analyzed using elastic half space theory. In case the foundation is supported over piles, Novak's approximation shall be used for determining the spring constant and damping ratio of pile groups. The mass of the RCC block shall be at least three times the mass of machine. Free vibration analysis of the foundation shall be carried out to evaluate the natural frequencies. The fundamental natural frequency shall be kept at least 20% away from the operating frequency (speed). Forced vibration analysis shall be carried out if the dynamic forces are made available by the machine supplier in which case the amplitude limits

	stipulated by the machine supplier and ISO 10816, whichever is lower, shall be satisfied. Reinforcement design shall be done by working stress method as per IS:456-2000 and IS:2974 (Part-IV). b) For the foundations supporting minor rotating equipment weighing less than one ton or if the mass of the rotating parts is less than one hundredth of the mass of the foundation, no dynamic analysis is necessary. However, if such minor equipment is to be supported on building structure, floors, etc., suitable vibration isolation shall be provided by means of springs, neoprene pads, etc., and such vibration isolation system shall be designed suitably.
6.03.22	If RCC floor/roof is assumed to act as diaphragm, transmitting lateral loads to braced bays, it shall be provided with shear connectors. However, whenever large / more number of cut-outs are provided in the floor slab, horizontal floor bracings shall be provided below slab to transfer horizontal force to columns without considering diaphragm action from slab.
6.03.23	All roads shall be rigid pavements specified elsewhere in this specification. The design traffic load shall be a minimum 4 million cumulative standard axle. The design of concrete pavement shall be carried out as per IRC-58.
6.03.24	a) No cable/pipe trench is envisaged in the plant area. However, if required, pipe/cable trench can be provided inside the buildings and inside switchyard or some other localised areas. b) All pipes and cable shall generally be routed above ground. c) A minimum clearance (clear headroom) of 8 m shall be kept for all over-ground pipe/cable trestles for all road/rail crossings. For other areas, the requirement of trestle height is specified elsewhere in the specifications. All trestles shall be provided with continuous walkway of minimum 600mm width with hand-rails and toe-guards all along the length of the trestle along with approach ladders near roads, passageways, etc.Before and after the road/rail crossings, a barrier of suitable height shall be constructed so as to prevent the approach of cranes (having height more than 8 m) etc, upto the pipe/cable racks/trestles. d) Within AB bay in Main plant area, generally grating shall be provided for Mezzanine floor except for valve room area, cable spreader floor, etc. where the floor shall be of RCC. Oil equipment room shall also have RCC floor below the grating floor.
6.03.25	Appendix –(1)“Area Drainage Study for Patratu Super Thermal Power Project” is enclosed. The plant storm water drainage shall be designed taking into account the finished grade levels of the plant area, drainage pattern, intensity of rainfall, etc., The storm water drainage shall cater to storm water run off resulting from one hour rainfall intensity, with a return period of 50 years. These values shall be based on the "Detailed Area Drainage Study" subject to minimum rainfall intensity of 75mm/hr. The maximum velocity for pipe drains and open drains shall be limited to 2.4m/sec and 1.8 m/sec. respectively. However, minimum velocity of 0.6m/sec. for self-cleansing shall be ensured. Bed slope not milder than 1 in 1000 shall be provided. The open drains shall be open rectangular drains of RCC unless required otherwise due to functional requirement. RC box culverts shall be provided at rail, road or other crossings.
6.03.26	Sewers shall be designed for a minimum self-cleansing velocity of 0.75m/sec and the maximum velocity shall not exceed 2.4m/sec. Manual on sewerage and sewage treatment (published by Central Public Health Environment Engineering Organisation, Government of India) shall be followed for design purpose.
6.03.27	**NOT USED**
6.03.28	Foundations for all tanks shall be designed for as per IS: 803.

6.03.29 Footings shall be so proportioned to as to minimise the differential settlement.

6.03.30 **Boiler/ ESP support structures shall be designed for:**

a. Dead load

b. Live/Imposed loads

c. Static and dynamic loads of piping, movable equipment and maintenance parts.

d. Loads from cable trays and walkways supported on columns.

e. Ash water piping supported on the outermost row of boiler columns.

f. All ESP hoppers filled up with ash upto the top of the hoppers or the bottom of electrodes (whichever is more) using a bulk density of not less than 1350 kg/cu.m. for the ash, along with additional ash build-up from the end of the third field upto the inlet duct bottom level at a natural repose angle (not less than 30 degree to horizontal in any case).

g. Ash load at bottom ash hopper and pent house of the boiler shall be as mentioned in the mechanical chapter of the specifications.

h. Seismic and wind loads as specified elsewhere in the specifications.

i. Temperature Loads.

j. Temperature variations under ESP operating condition.

k. The loads listed above indicate the minimum requirements.

l. For the Design of ESP Supporting Structures for Seismic, Ash Load in Hoppers filled upto to the top of the Hoppers or bottom of the electrode (whichever is higher) shall be considered as permanent Loads along with other applicable Loads.

m. Following Ash density shall be considered for the Design :

Sl.No.	Description	Density (Kg/Cu. M.)
a)	Bottom Ash for volume calculations	650
b)	Bottom Ash for Load calculations	1600
c)	Fly Ash for volume calculations (For Boiler)	750
d)	Fly Ash for volume calculations (For ESP)	650
e)	Fly Ash for Load calculations	1350
f)	Dry Fly Ash for dry fly ash Pipeline supporting Structures (Pipe to be considered full)	1000

6.03.31 Boiler supporting structures shall be so configured that the temperature of steel does not exceed 60 °C unless specified otherwise. Brackets shall be provided on both sides of the outermost row of columns of both the boiler and ESP for supporting cable trays and walkways, at a height not exceeding 10.0 m. The exact levels shall, however, be decided during detailed engineering. Each ESP hopper shall be supported at four corners by providing four columns from the ground.

6.03.32 The bracings in boiler structure shall be provided such that under no circumstance

normal/convenient access to all points in the boiler is blocked or obstructed.

6.03.33 In design of boiler/ ESP support structures, dynamic piping loads need not be considered acting simultaneously with wind or seismic loads. Increase in permissible stresses shall be allowed in load combinations where dynamic piping loads are considered and shall be as permitted under seismic load conditions.

6.03.34 Design Criteria for foundations and some other facilities/areas are covered separately in this specification.

6.03.35 Plinth level of all buildings shall be kept at least 500 mm above the finished grade/formation level.

Finished floor level of boiler area paving shall be kept about 200 mm lower than the finished floor level of Main Plant buildings.

6.03.36 Joints/Connections in steel structures:

Steel structures shall be detailed and connection and joints provided as per the provisions of IS:800, IS:816, IS:9595, IS:1367, and IS:9178 and as per following requirements.

a) Connection of vertical bracings with connection members and diagonals of truss members shall be designed for full tensile capacity of the bracings unless actual loads are indicated on the drawings.

b) Size of fillet weld for flange to web connection for built up section shall be as follows:

i) For box section weld size shall be designed for full shear capacity or actual shear whichever is more. Where fillet weld is not possible, full penetration butt weld shall be provided.

ii) For built up I section, weld size shall be designed for 80% of full shear capacity or actual shear, (if indicated, in drawings) whichever is more. However, weld size shall not be less than 0.5 times the web thickness. Weld shall be double fillet.

iii) All welds shall be continuous unless otherwise specifically approved. The minimum size of the fillet weld shall be 6mm.

c) Shear connections shall be designed for 60% of section strength for rolled sections and 80% of section strength for built up section or rolled section with cover plates. However, if load is more than above, the connection shall be designed for actual load.

d) Moment connections between beam and column shall be designed for 100% of moment capacity of the beam section.

e) All butt welds shall be full penetration butt welds.

f) The connection between top flange and web of crane girder shall be full penetration butt weld. Bottom flange, connection with web can be fillet weld or butt weld as directed by Engineer.

g) Connection of base plate and associated stiffeners with the columns shall be designed considering the total load transferred through welds. However, minimum weld size (double fillet) shall not be less than 0.6 times the thickness of stiffeners.

h) Splicing: All work shall be full strength. Field splicing shall be done with web and flange cover plates for full strength. Shop splicing for all sections other than rolled shall be carried out by full penetration butt welds with no cover plates. Splicing for all rolled sections shall be carried out using web and flange cover plate.

6.03.37 Pipe Pedestals, pipe supports and other structures for Ash handling system:

a) The design of Pipe Pedestal and pipe supports shall be carried out considering Dead

load, live load & seismic load / wind load. In addition to above, longitudinal forces equal to product of Co - efficient of friction (between contact surface of pipe and pedestal) with the load coming on each pedestal shall also be considered for the design of pedestal. In bends, suitable thrust block shall be provided to withstand the thrusts transferred from the pipelines.

b) All RCC pipes carrying water under gravity shall be designed for earth pressure, water and surcharge. Minimum grade of pipe shall be of NP - 2 class or heavier required as per design / specification.

c) The design and construction of RCC structures shall be carried out as per IS: 456. In general, limit state theory shall be followed for the design of RCC structures, however, working stress method shall be adopted for the design, wherever specifically mentioned in this specification.

d) Two layers of reinforcement (on inner and outer face) shall be provided for RCC wall sections having thickness 150mm and above.

6.03.38 Design Criteria of RCC Floors

a) For Main Power House, Mill Bunker Building, ESP Control Building, Transfer Houses of CHP, and other structural steel framed buildings:

These buildings being steel framed structure, all RCC floors shall comprise RCC slab supported on troughed, profiled metal deck sheet of minimum thickness 0.80mm (to be used as permanent shuttering). The RCC slab shall be minimum 150mm thick above the top surface (crest) of the metal deck sheet. The spacing of structural steel secondary beams shall be based on the bending capacity of the metal deck sheet for self weight of green concrete and additional construction load of 100 kg/m2.

The permanent metal deck sheets shall be fixed to the top flange of secondary beams by means of drawn arc welding of headed shear anchor studs directly through the metal sheet. The details of shear anchor studs are specified elsewhere in this specification.

The RCC slab shall be designed without considering any composite action effect of metal deck sheet (ie the structural strength of metal deck sheet shall not be considered for RCC slab design).

(b) For Administrative Building, Service Building, CISF building & other RCC buildings.

These buildings being complete RCC framed structures, conventional RCC slabs of minimum thickness 125mm shall be provided. The RCC slabs shall be monolithic with RCC beams and RCC columns

6.03.39 **Design Criteria of RCC roofs:**

a) For Main Power House, Compressor House, ESP Control Building:

The roof system shall comprise minimum 40mm thick RCC slab on top of profiled permanent metal deck sheet. The permanent metal deck sheets shall be fixed to the top flange of secondary beams by means of arc welding of headed shear anchor studs to the purlins directly through the metal sheet. The details of shear anchor studs are specified elsewhere in this specification. Water proofing treatment to roof slab shall be provided as per details specified elsewhere in this specification).

The RCC slab shall be designed without considering any composite action effect of metal deck sheet (ie the structural strength of metal deck sheet shall not be considered for RCC slab design.

b) For Mill Bunker Building, Transfer Houses.

Insulated sandwiched metal sheet for roofing shall be provided comprising troughed permanently colour coated sheet at top and plain permanently colour coated sheet at

bottom with 50mm thick insulation sandwiched between the two sheets, the details of which are specified elsewhere in this specification.

c) Other RCC Buildings.

Cast-in-Situ RCC slab shall be provided using removable plywood shuttering. Water proofing treatment to roof slab shall be provided as per details specified elsewhere in this specification).

6.03.40 Design Criteria for Foundation

The founding depth / cut off level of piles shall be decided based on functional requirement.

Where structural steel columns are envisaged, the bottom of the base plate shall be kept suitably below the paving level such that the top level of the gusset plate and foundation bolt remain at least 200 mm below the top level of paving except for Main power House Building columns, Boiler Structure, Bunker Building Columns, TP & Trestle Columns, ESP Control Building Columns for which the requirement of levels for bottom of base plates is specified elsewhere in this specification. Further the gusset plate and foundation bolts are to be encased in concrete up to the top of the paving level. For outdoor structural steel columns, about 300 mm height of steel columns above the top of paving level shall be provided with at least 125 mm thick encasement with minimum reinforcement to prevent corrosion of the steel columns from surface water

a)OPEN Foundations

For all major foundations, the minimum founding depth and the minimum size of foundation shall be as per foundation system and geotechnical data specified in the foundation chapter include hereafter in this specification.

For open foundations, the total permissible settlement shall be as per the criteria furnished under the foundation system specified elsewhere in this specification.

The sizing of foundation, design criteria & clear cover shall conform to IS:1904, IS:456 and other relevant Indian codes. However minimum 0.12% of reinforcement shall be provided on the top face of the foundation concrete on either direction and minimum percentage of reinforcement at bottom face of foundation shall be same as that stipulated for beam as per IS:456.

No major foundation shall rest on filled up soil. Loose soil if any below foundation is to be removed and replaced with PCC of grade M7.5.

b)PILE Foundations

Minimum centre to centre spacing of the piles shall be 3 times the diameter of pile. Incase single piles are used, these piles are to be interconnected with tie beams along both orthogonal directions perpendicular to each other.

Minimum penetration of piles into Pilecap shall be 75 mm and clear cover to the main reinforcement at the bottom face of the pile cap shall be 100 mm. Structural design of pile cap and reinforcement shall conform to IS:2911 and IS:456. However minimum 0.12% of cross section of the pile cap shall be provided on the top face of the pile cap along two orthogonal directions and minimum percentage of reinforcement at bottom face of pile cap shall be same as that stipulated for beam as per IS:456.

Detailed requirement of pile foundation have been presented in the foundation chapter specified hereafter in this specification.

6.03.41 **Coal Handling Plant structures**

a) The loads for all railway load bearing structures e. g. track hopper including machinery hatches, tunnel, culverts and under ground transfer houses etc. and the analysis and the design of these structures shall be made strictly in accordance with the provisions

of Indian Railway Bridge rules (latest edition), and Indian Railway Codes of practice (latest edition) with all amendments up .to the date of opening of bids. However, the axle load for analysis and design shall be considered as "DFC loading 32.5 MT axle load". Coal heap of 1.2m height shall be considered above hopper top for design of coal tray, hopper and supporting elements of track hopper. The analysis, design and detailed drawing for the structure coming below the railway track shall be got approved by the Bidder from the concerned railway authorities before taking up construction. All necessary payment for the above work shall be made by the bidder to the railway authority.

b) The crusher and transfer house structures shall be so designed that transverse deflection at places where conveyor galleries meet, should be equal to the respective transverse deflection of conveyor supporting trestles.

c) Design of Hopper walls shall be done for both Static & Dynamic flow condition using Walker's theory

d) Minimum size of the angle section to be used as structural members shall be 50 X 50 X 6. Minimum weld size shall be 6 mm.

e) The buildings shall conform to local bye - laws, rules and regulations for industrial buildings and also B. I. S. publications, SP 32 and 41.

f) Slotted holes shall not be assumed to act as expansion joint for relieving of stresses and suitable bearings shall be provided at the supports.

g) Shear force in steel columns shall be transferred to the pedestals / foundations exclusively either through foundation bolts or the shear key arrangement.

h) For design of R. C. C. pipes for culverts, latest editions of IS : 458, IS : 783 should be followed.

i) Design of masonry walls shall be made as per IS : 1905.

j) Minimum reinforcement shall be provided at the top face of the footing, even if, no reinforcement is required as per design.

6.04.00 **Corrosion Protection**

6.04.01 **GENERAL**

(a) All equipments, pipes, etc. shall be painted as per the requirements specified in the relevant section of the specification.

(b) All Steel structures shall be provided with painting as given in the specification. Further, painting system shall also meet the requirements of Corrosivity category C3 (durability High) as per ISO 12944.

Painting system for steel surfaces embedded in Concrete is given separately.

(c) All Paints shall be of high build constitution.

(d) All Painting shall be done as per approved Painting scheme of the Vendors / Manufacturers, which shall be submitted by the Bidder and as approved by the Employer.

(e) All steel structures shall be designed by following basic design criteria in ISO 12944 Part 3 ■

(e) All steel structures shall be designed by following basic design criteria in ISO 12944 Part 3. However, where it is not feasible to follow the design criteria given in ISO 12944 Part 3 where the steel surface are inaccessible for application of protective coating, corrosion allowance of 1.5 mm shall be kept in thickness(over the design thickness) of structural steel members for Patratu Super Thermal Power Station.

6.04.02 **PAINTING OF STEEL SURFACES EMBEDDED IN CONCRETE:**

a) For the portion of Steel surfaces embedded in Concrete, the surface shall be prepared by Manual Cleaning and provided with Primer Coat of Chlorinated Rubber based Zinc Phosphate Primer of Minimum 50 Micron Dry Film Thickness (DFT).

b) All threaded and other surfaces of foundation bolts and its materials, insulation pins, Anchor channels, sleeves, etc. shall be coated with temporary rust preventive fluid and during execution of civil works, the dried film of coating shall be removed using organic solvents.

6.04.03 PAINTING OF STEEL SURFACES (OTHER THAN THOSE EMBEDDED IN CONCRETE)

d) All steel surfaces shall be provided with two component moisture curing zinc (ethyl) silicate primer coat (having minimum 80% of metallic Zinc content in dry film, solid by volume minimum 60% ±2%) of minimum 70 micron DFT to be applied over blast cleaned surface conforming to Sa 2 ½ finish of ISO 8501-1 with surface profile 40-60 Micron. The primer coat shall be applied in shop immediately after blast cleaning by airless spray technique. Zinc dust composition and properties shall be Type-II as per ASTM D520-00

e) Primer coat shall be followed with the application of Intermediate coat of two component polyamide cured epoxy with MIO Content (containing lamellar MIO minimum 30% on pigment, solid by volume minimum 80% ±2%) of minimum 100 micron DFT. This coat shall be applied in shop after an interval of minimum 24 hours (from the application of primer coat) by airless spray technique.

f) Intermediate coat shall be followed with the application of finish coat of two-pack aliphatic Isocyanate cured acrylic finish paint (solid by volume minimum 55% ±2%) with Gloss retention (SSPC Paint Spec No 36, ASTM D 4587, D 2244, D 523) of Level 2 (after minimum 1000 hours exposure, Gloss loss less than 30 and colour change less than 2.0 ΔE) and minimum 70 micron DFT. This coat shall be applied shop after an interval of minimum 10 hours and within six (6) months (from the completion of Intermediate coat), Colour and shade of the coat shall be as approved by the Employer.

Notes:

1. For Primer, high quality surface preparation is necessary and good amount of moisture is required for proper curing. Below 70 % relative humidity, curing time may go up to 7 days or more. In such a case additional water sprinkling may be ensured for completion of curing. Additionally Inorganic zinc silicate cannot be recoated; even with itself. Typically it should be used when coating bare steel surface for first time.
2. The most frequent problem associated when top coating Primer is bubbling/pinholing especially with non-weathered zinc silicate coatings. To a great extent, this bubbling of finish paint can be eliminated by applying a mist coat of intermediate/topcoat as the first pass of the product, allow the bubbles to subside and then apply a full coat, as required.
3. In case topcoating of zinc silicate with epoxy/polyurethane coatings, is expected to be delayed, it is advisable to use a suitable tie coat to avoid formation of white rust. However, if white rust forms then clean the surface with high pressure water, dry and apply the subsequent coats as required.
4. Touch up paintings on damaged areas: Surface preparation by manual tools, wire brush/ emery paper etc. Minimum 6 inches peripheral area, adjoining to damaged area to be covered. If metal surface is exposed, it is to be painted with Zinc rich epoxy (70 micron) or suitable primer with existing paint scheme. If primer is intact, intermediate & top coat to be done with specified DFT in scheme.

6.04.04 **TOUCH-UP PAINTING ON DAMAGED AREAS**

a) For Coatings damaged up to metal surface

Surface preparation shall be carried out by Manual Cleaning. Minimum 6 inches adjoining area with existing Coating shall be roughened by Wire brushing, emery paper rubbing etc., for best adhesion of patch Primer.

Over this Primer Coat, Intermediate Coat, Finish Coat and Final Finish Coat shall be applied as covered above by brush with Intermediate Coat applied within maximum seven (7) days of application of touch up Primer.

b) For Coatings damaged upto Intermediate Coatings (i.e. where Primer Coat is intact).

Damaged area including Minimum 6 inches adjoining area with existing Coating should be roughened by wire brushing, emery paper rubbing etc., for best adhesion of patch Primer without damaging the Primer Coat.

Touch-up Primer, Intermediate, Finish and Final Finish Coats shall be applied as specified above for Coatings damaged up to metal surface.

6.04.05 Painting of welded areas / painting of areas exposed after removal of temporary supports / touch-up painting on damaged areas structures, where inter-connection, welding / modification etc. Has been carried out by the bidder.

a) Clean the surface to remove flux spatters and loose rust, loose Coatings in the adjoining areas of Weld seams by wire brush and emery paper.

b) Painting procedure to be followed as mentioned above for Touch-up Painting on damaged areas.

6.04.06 Dry film thickness of each coat shall be checked and measured as per the procedure specified in paint application standard no. 2 by SSPC: The Society for Protective Coating. The thickness as measured shall not be less than the minimum thickness specified for the coat of paint under relevant clauses of technical specification.

6.04.07 Coating for Mild Steel parts in contact with Water.

a) All mild Steel parts coming in contact with water or water vapour shall be hot dip galvanised. The Minimum Coating of Zinc shall be 610 Gms / Sq. M. for galvanised Structures and shall comply with IS: 4759 and other relevant Codes. Galvanising shall be checked and tested in accordance with IS: 2629.

b) The galvanising shall be followed by the application of an etching Primer and dipping in black bitumen in accordance with BS: 3416, unless otherwise specified.

6.04.08 Gratings

All gratings shall be blast cleaned to Sa 2 ½ finish as per ISO 8501-1and shall be hot dip galvanized at the rate of 610 Gms / Sq. M.

6.04.09 Hand Railings and Ladders

All Mild steel handrails and ladders shall be galvanised at the rate of 610 Gms / Sq. as per IS: 4736. However, Stainless steel handrails shall be provided as specified in General Architectural Specification clause 9.0.0.

6.04.10 Sea Worthiness

All Steel Sections and fabricated Structures, which are required to be transported on sea, shall be provided with anti corrosive Paint before shipment to take care of sea worthiness.

6.04.11 All structural steel members in switchyard (excluding fencing and gate) shall be hot dip galvanised as specified elsewhere.

6.04.12 **For reinforced concrete work.**

i) The protection for concrete sub-structure shall be provided based on aggressiveness of the soil, chemical analysis of soil/sub-soil water and presence of harmful chemicals/salts.

ii) The protection to super structure shall depend on exposure condition and degree of atmospheric corrosion.

This shall require use of dense and durable concrete, control of water cement ratio,

increase in clear cover, use of special type of cement and reinforcement, etc., coating of concrete surface, etc.,

Bidder shall furnish the details of corrosion protection measures.

7.00.00 **FOUNDATION SYSTEM AND GEOTECHNICAL DATA** For detail Refer Annexure-1

7.01.00 **Soil Data**

Owner has carried out preliminary geotechnical investigation at the project site. Available borelogs along with laboratory test results, are enclosed at Annexure-A for Bidder's reference. The preliminary geotechnical investigation report for these areas will be made available for the Bidder's study at the Owner's office, if required.
Onus of correct assessment/ interpretation and understanding of the existing subsoil condition / data is on the Bidder. Bidder may refer topographical survey drawing for variation in existing ground level.

7.01.01 Contractor shall carryout detailed soil investigation for the facilities under this package. The scheme for geotechnical investigation shall be as given at **Clause 7.08.00** and shall be approved by Owner before execution. Geotechnical investigation work shall be got executed by the contractor through the agencies as mentioned in Clause No. 7.07.00. The geotechnical investigation report shall be prepared with detailed recommendations regarding type of foundation and allowable bearing pressure for various structures/ facilities and other soil parameters. The report shall be submitted for Owner's approval prior to commencement of design of foundation.

7.01.02 The Bidder should note that nothing extra whatsoever on account of variation between soil/rock data collected by Owner and that found by the contractor during detailed geotechnical investigation by him or during execution of works, shall be payable.

7.01.03 Tank Foundations

a) The tanks shall rest on flexible tank pad foundation, resting on sand with concrete ring wall to retain sand. Base of the concrete ring wall shall not rest on the expansive soil, if any.

b) Entire loose/ soft soil inside the concrete ring wall shall be removed and shall be filled with sand. Sand for filling shall be clean and well graded conforming to IS 383 with grading Zone I to III.

c) Sand shall be spread in layers not exceeding 30cm compacted thickness over the area. Each layer shall be uniformly compacted by mechanical means like plate vibrators, small vibratory rollers, etc to achieve a relative density of not less than 80%.

d) Other requirements of tank foundations shall be as per IS 803 and as specified elsewhere in the specifications.

7.02.00 **Foundation System**

The requirements for the foundation system to be adopted are as given in subsequent clauses. Depending upon the depth of competent strata/stratum, type of structures, functional requirement of facility, extent of cutting / filling, suitable foundation, open or pile shall be adopted with approval of owner.

7.02.01 **General Requirements**

a) All structures/equipment shall be supported either on suitable open foundations (isolated, combined, raft) or pile foundations depending on type of structures/facilities, sub-strata, topography etc.

b) The roads, ground floor slabs, trenches, pipe pedestals, channels/drains and staircase foundation with foundation loading intensity less than 4 T / M2 may be supported on open / shallow foundations resting on virgin / controlled compacted filled up soil. If the encountered sub-strata is black cotton soil, the same shall be either replaced upto the full depth or black cotton soil shall be stabilized by suitable treatment.

c) No other foundation (other than as mentioned in (b) above) shall rest on the filled up ground / soil.

d) All foundations shall be designed in accordance with relevant parts of the latest revisions of Indian Standards.

e) The water table for design purpose shall be considered at Finished Ground Level.

f) A combination of open and pile foundations shall not be permitted under the same equipment / structure / building.

g) Foundation for equipments on ground floor

For equipments of static weight upto 1.5 T, the equipment may be supported on the ground floor slab by locally thickening the slab. Thickening of the ground floor slab shall be done upto an extent of about 0.6 m beyond the plan area of the equipment on all the sides. Further, the load intensity below the equipment shall be limited to 4T/m2. Other requirements of floor slab and compaction below the floor slab shall be adhered, as specified elsewhere in the specifications.

For equipment of static weight more than 1.5 T, the equipment foundation shall be taken to the founding level or shall be built up with PCC from the level as mentioned in the Annexure-I. The pedestal of equipment foundation or the foundation Block shall be isolated from the adjoining floor slab by providing bitumen impregnated fiber board of minimum 50 mm thick, conforming to IS: 1838 all around the equipment pedestal for the full depth of the floor slab.

7.02.02 Open Foundations

In case open foundations are adopted, following shall be adhered to.

a) The minimum width of foundation shall be 1.0 m.

b) Minimum depth of foundation shall be 1.0m below Ground Level.

S. No 381 Amendment-4: All foundation in a particular Structure (between expansion joint) shall rest on particular stratum based on geotechnical consideration. Where large variation in stratum is observed , the foudnation level to be maintained by building up with PCC from the intended stratum.

c) ~~It shall be ensured that all foundations of a particular structure/ buildings/ facility shall rest on one bearing stratum~~.

d) Wherever the intended bearing sub-strata is virgin soil stratum but the actual stratum encountered during foundation excavation consists of filled up soil at founding level, under such cases either the foundation shall be lowered completely into the virgin stratum or the filled up soil upto the virgin layers shall be removed and built up through PCC up to designed foundation level.

e) No foundation shall rest in black cotton soil.

f) Contractor shall carry out detailed geotechnical investigation, the maximum allowable bearing pressure shall be as per the approved geotechnical report and shall be limited to the values as furnished in Table-1.

Table-1

Founding Depth/ Stratum	Net Allowable Bearing Pressure T/m2		
	Isolated and combined footings including raft for 25mm permissible settlement in case of soil and 12mm in case of rocky strata	Isolated and combined footings for 40mm permissible settlement in case of soil and 12mm in case of rocky strata	Rafts (width > 6m) for 75mm permissible settlement in case of soil and 12mm in case of rocky strata
	Width upto 6.0m		
In case of foundation stratum is soil			
1.0m below NGL	-	8	10
2.0m below NGL	-	12	15
3.0m below NGL	15	18	20
In case of founding stratum is rock			
0.5m embedment into very dense sand with SPT 'N' Value more than 60 and upto 100	30	35	35
1.0m embedment into disintegrated rock, into very dense sand with SPT 'N' Value more than 100	40.0	40.0	40.0
2.0m embedment into disintegrated rock	50.0	50.0	50.0

In case any loose/soft pockets in rocky strata is encountered at founding level, the same shall be removed completely upto the hard strata and filled up with PCC (1:4:8).

g) For open foundations, the total permissible settlement and differential settlement shall be governed by IS: 1904 / IS: 13063 and from functional requirements whichever is more stringent. However, total settlement shall be restricted to the following:

Isolated & Raft (Main power house, TG Area Footings, Boiler, Mill, Bunker Footings & Fans)	25 mm

Isolated & Strip (other than Main power house, TG Area Footings, Boiler, Mill, Bunker Footings & Fans)	40 mm
Raft (other than Main power house, TG Area Footings, Boiler, Mill, Bunker Footings & Fans)	75 mm
Foundations in Weathered rock / rock	12 mm

Incase pile foundations are to be adopted the requirements under para "Pile Foundations" shall be adhered to.

7.02.03 Pile Foundations –

In case piles are adopted, following shall be adhered to :

i) The pile foundation shall be of RCC, Cast-in-situ bored piles as per IS:2911. Pile boring shall be done using Rotary Hydraulic Rigs. Two stage flushing of pile bore shall be ensured by airlift technique duly approved by the Employer.

If required, temporary or permanent MS liner may be provided for piling.

ii) The minimum diameter of pile shall be 600 mm. The allowable load capacity of the pile in different modes (vertical compression, lateral and pullout) shall be as per approved geotechnical report & shall be limited to the values given below:

Pile	Dia. (mm)	Vertical compression capacity (T)
Bored cast-in-situ pile	600	140
	760	250

The piles shall be socketed 5m (minimum) into rock.

The uplift and lateral load capacity shall be respectively restricted to 35% and 5% of the allowable load capacity in vertical compression.

However, the pile capacities to be adopted shall be the least of the estimated design values and that obtained from the initial pile load tests.

iii) Only straight shaft piles shall be used. Minimum cast length of pile above cutoff level shall be 1.0 m.

iv) The contractor shall furnish design of piles (in terms of rated capacity, length, diameter, termination criteria to locate the founding level for construction of pile in terms of measurable parameter, reinforcement for job as well as test piles, pile load test arrangement, locations of initial test piles etc.) for Engineer's approval.

v) The piling work shall be carried out in accordance with IS:2911 (Relevant part) and accepted construction methodology. The construction methodology shall be submitted by the Contractor for Engineer's approval.

vi) Number of initial load tests to be performed for each diameter and rated capacity of pile shall be subject to minimum as under.

Vertical

Lateral Minimum of 4 Nos. in each mode.

Uplift

vii) The initial pile load test shall be conducted with test load upto three times the estimated pile capacity. In case of vertical compression test (initial test) the method of loading shall be cyclic as per IS:2911 (relevant part).

viii) Load test shall be conducted at pile cut of level (COL). If the water table is above the COL the test pit shall be kept dry throughout the test period by suitable de-watering methods. Alternatively the vertical load test may be conducted at a level higher than COL. In such a case, an annular space shall be created to remove the effect of skin friction above COL by providing an outer casing of suitable diameter larger than the pile diameter.

ix) Number of routine pile load tests to be performed for each diameter/allowable capacity of pile shall be as under :

i) Vertical : 0.5% of the total number of piles provided.

ii) Lateral : 0.5% of the total number of piles provided.

x) The routine tests on piles shall be conducted upto test load of one and half times the allowable pile capacity. Piles for routine load tests shall be approved by the Employer.

xi) In case, routine pile load test shows that the pile has not achieved the desired capacity or pile(s) have been rejected due to any other reason, then the Contractor shall install additional pile(s) as required and the pile cap design shall accordingly be reviewed and modified, if required.

xii) Testing of piles and interpretation of pile load test results shall be carried out as per IS:2911 (Part-4). Contractor shall ensure that all the measuring equipment and instruments are properly calibrated at a reputed laboratory / institute prior to their use. Settlement / movement of the pile top shall be made by Linear Variable Differential Transducers (LVDT) having a least count of 0.01mm.

xiii) The test load on initial test piles shall be applied by means of reaction from anchor piles / rock anchors alone or combination of anchor piles / rock anchors and kentledge with concrete blocks.

xiv) Low Strain Pile Integrity test shall be conducted on all test piles and job piles. This test shall be used to identify the routine load test and not intended to replace the use of static load test. This test is limited to assess the imperfection of the pile shaft and shall be undertaken by an independent specialist agency to be approved by Engineering department of Owner. The test equipment shall be of TNO or PDI make or equivalent. The process shall confirm to ASTM.

xv) High Strain Dynamic Load Test may be carried out for routine load testing of working piles. However, at least three numbers of static routine vertical load tests shall be carried out on pile on which high strain dynamic load test has already been carried out for establishing the correlation between the two tests. In case of discrepancy if any between dynamic and static vertical load tests, then additional static routine vertical load tests shall be conducted as decided by the Engineer and the results of static routine vertical load shall prevail. Number of routine vertical pile load tests as per clause 7.02.03 (xi) shall be total of static routine vertical load test and high strain dynamic load tests.

The procedure to carry out the test shall be submitted to the Engineer. The test and equipment shall conform to ASTM D4945-00. The test shall be conducted by an experienced independent test agency approved by the owner. Field data shall be submitted to the site engineer and shall include force velocity curves, pile capacity, simulated static load test curve, net and total pile displacement, pile integrity. A (Case pile wave analysis) CAPWAP or equivalent software analysis shall be conducted on the field data for correct capacity estimation and to evaluate end bearing and skin friction components of the pile.

xvi) From load considerations, single pile may be used under a column/tower. In that case, pile shall be connected with tie beams at pile cut off level in both directions.

xvii) Contribution of frictional resistance of filled up soil if any, shall not be considered for computation of frictional resistance of piles.

xviii) Reinforcement for job piles shall be designed as following:

(a) Compression + bending piles: For these piles, the allowable safe pile capacities in compression and bending shall be considered.

(b) Tension + bending piles: For these piles, the actual pile forces to be considered. However, maximum 3 types of combinations for varying percentage of tension capacity + bending case may be designed & adopted by contractor for the entire scope of work under this package.

7.03.00 Special Requirements

7.03.01 Details of treatment for foundations / underground structures required to counteract soil / water chemical environment shall be as per detailed geotechnical investigation to be carried out by contractor. Contractor shall carry out chemical analysis during detailed geotechnical investigation and required treatment shall be provided accordingly.

7.04.00 Excavation, Filling and Dewatering

7.04.01 For excavation works, comprehensive dewatering with well point or deep wells arrangement, if required, shall be adopted. Scheme for dewatering and design with all computations and back up data for dewatering shall be submitted for the owner's information. The water table shall be maintained at 0.5m below the founding depth.

7.04.02 Excavation for shallow foundations shall be covered with PCC immediately after reaching the founding level. In case of any local loosening of soil or any loose pockets are encountered at founding level during excavation the same shall be removed and compensated by PCC M7.5. The final layer of about 300 mm thickness above the founding level shall be excavated by suitable means, so as to avoid disturbance to founding stratum.

7.04.03 Backfilling around foundations, pipes, trenches, sumps, pits, plinths, etc. shall be carried out with approved material in layers not exceeding 300 mm compacted thickness (higher thickness of layers upto 500mm with heavy mechanical compacting equipment) and each layer shall be compacted to 90% of standard proctor density for cohesive soils and to 75% of relative density for non cohesive soils. In any case, black cotton soil shall not be used in back filling without providing cushion of 1m of non expansive cohesive soil / moorum around the footings. In case of roads in the area of black cotton soil, minimum 0.4m moorum shall be provided.

Rock pieces having size less than 150 mm and interstices filled with soil may be used for backfilling around foundation, plinths etc. and shall be compacted to minimum of 85% of original stack of material after filling the interstices.

7.04.04 Founding level for trenches/channels shall be decided as per functional requirement. The bottom of excavation shall be properly compacted prior to casting of bottom slab of trenches / channels.

7.04.05 CBR tests for pavement/road design shall be carried out by the Contractor after earth filling (if applicable) has been completed upto the formation level.

7.04.06 The contractor shall take all necessary measures during excavation to prevent the hazards of falling or sliding of material or article from any bank or side of such excavation which is more than one and a half meter above the footing by providing adequate piling, shoring, bracing etc. against such bank or sides.

Adequate and suitable warning signs shall be put up at conspicuous places at the excavation work to prevent any persons or vehicles falling into the excavation trench. No worker should be allowed to work where he may be stuck or endangered by excavation machinery or collapse of excavations or trenches.

7.05.00 EXCAVATION IN ROCK

Excavation in rock shall be carried out by mechanical means and if blasting is required for founding of some of the structures under this package, control blasting only shall be carried out.

7.05.01 Controlled blasting shall be done by a specialised agency duly approved by Engineer. All controlled blasting shall be done by using time delay detonators (i.e. excel type).

7.05.02

a) Contractor shall engage an agency expert in blasting such as, CMPDIL, CMRI, Dept. of Mining of Govt. Institutions, etc. to design detailed blasting scheme and get the same approved from Engineer before carrying out the blasting operation. All blasting shall be done as per the approved blasting scheme & initial blasting operations shall be done under the supervision & guidance of the representative of the blasting expert.

b) All the statutory laws, (Explosives Act etc.) rules, regulations, Indian Standards, etc. pertaining to the acquisition, transport, storage, handling and use of explosives, etc. shall be strictly followed.

c) The Contractor shall obtain Licenses from Competent Authorities for undertaking blasting work as well as for procuring, transporting to site and storing the explosives

as per explosives act. The Contractor shall be responsible for the safe transport, use, custody and proper accounting of the explosive Materials.

d) The Contractor shall be responsible and liable for any accident and injury / damage which may occur to any person or property of the project or public on account of any operations connected with the storage, transportation, handling or use of explosive and blasting operations.

7.06.00 Sheeting & Shoring

The contractor shall ascertain for himself the nature of materials to be excavated and difficulties, if any, likely to be encountered in excavation while executing the work. Sheet piling, sheeting and shoring, bracing and maintaining suitable slopes, drainage, etc. shall be provided and installed by the Contractor, to the satisfaction of the Engineer.

For deep excavation in CHP area, sheet piling / contiguous pile / secant pile / diaphragm walls may be required depending upon the proximity to the existing facilities. The excavation design & scheme shall be developed by a specialized agency.

7.07.00 Geotechnical Investigation

The Contractor shall carry out detailed geotechnical investigation in the areas under his scope for establishing the sub-surface conditions and to decide type of foundations for the structures envisaged, construction methods, any special requirements/treatment called for remedial measures for sub-soil/ foundations etc. in view of soft sub-soils, aggressive sub-soils and water, expansive/swelling soils etc. prior to commencement of detailed design/drawings. The Contractor shall obtain the approval for the field testing scheme proposed by him from the Owner before undertaking the geotechnical investigation work.

7.07.01.00 **Scheme of geotechnical Investigation**

7.07.02.01 Field test shall include but not be limited to the following:

Boreholes, Standard Penetration Test (SPT), Dynamic Cone Penetration Test (DCPT), collection of disturbed samples (DS) and undisturbed soil samples (UDS), Trial Pits (TP), Plate Load Tests (PLT),Cyclic Plate Load Test(CPLT), Electrical Resistivity Test (ERT), Cross Hole Test, Pressure Meter Test (PMT), In situ field permeability tests, collection of water samples, etc.

7.07.02.02 The diameter of borehole shall be minimum 150 mm in soil and 76 mm in rock. The diameter of UDS sampler shall be 100 mm minimum.Core drilling in rock shall be done by using hydraulically feed rotary drill & double tube core barrel with diamond bit.

7.07.02.03 The minimum tests are indicated in Clause No**. 7.08.00.** Adequate number of tests shall be conducted up to sufficient depth for complete determination of subsoil conditions. The depth of boreholes shall be as specified in Clause No. 7.08.00. SPT shall be carried out in all types of soil deposits and in all rock formations with core recovery up to 20%, met within a borehole. This test shall be conducted at every 3.0 m interval or at change of strata, up to the final depth. SPT 'N' of 100 and above shall be referred as refusal. UDS shall be collected at every 3.0 m interval or at change of strata up to depth of borehole. UDS may be replaced by additional SPT, if SPT'N' value in the strata is above 50.

7.07.02.04 Laboratory tests shall be done as per relevant IS codes. The laboratory tests, not be limited to the following shall be conducted on disturbed and undisturbed soil samples, rock samples & water samples collected during field investigations in sufficient numbers.

Laboratory Tests on Soil Samples

Laboratory tests shall be carried out on disturbed and undisturbed soil samples for Grain Size Analysis, Hydrometer Analysis, Atterberg Limits, Triaxial Shear Tests (UU), Natural Moisture Content, Specific Gravity and Bulk Unit Weight, Consolidation Tests, Unconfined

Compression Test, Free swell Index, Shrinkage Limit, Swell Pressure Test, Chemical Analysis test on soil and water samples to determine the carbonates, sulphates, chlorides, nitrates, pH, organic matter and any other chemicals harmful to concrete and reinforcement/ steel.

Laboratory Tests on Rock Samples

Moisture content, porosity & density, Specific Gravity, Hardness, Soundness, Slake durability index, Unconfined compression test (Both at saturated and in-situ water content), Point load strength index and deformability test (Both at saturated and in-situ water content) shall be carried out on rock samples.

7.07.02.05 Geotechnical investigation (field & laboratory) shall be carried out in accordance with the provisions of relevant Indian Standards.

On completion of all field & laboratory work, geotechnical investigation report shall be submitted for Owner's review/approval. The Geotechnical investigation report shall contain geological information of the region, procedure adopted for investigation, field & laboratory observations/ data/ records, analysis of results & recommendations on type of foundation for different type of structures envisaged for all areas of work with supporting calculations. Recommendations on treatment for soil, foundation, based on subsoil characteristics, soft soils, aggressive chemicals, expansive soils, recommendation along with slope stability calculation for deep excavation, etc.

Recommendations on foundation system and the net allowable bearing pressures and pile capacity shall be based on the conservative values of geotechnical investigation data.

7.07.03.00 Geotechnical investigation work shall be got executed by the Contractor through the following agencies.

1. C.E.TESTING COMPANY Pvt. Ltd, Kolkata
2. CengrsGeotechnica Pvt. Ltd, New Delhi
3. M.K. Soil Testing Laboratory, Ahemdabad
4. SECON Pvt Ltd, Bangalore
5. Soil Engineering Consultants, New Delhi
6. Orbital Infrastructure Consultancy & Research Pvt. Ltd. Cuttack
7. KCT Consultancy Services, Ahemdabad
8. ARKITECHNO Consultants (India) Pvt. Ltd. Bhubaneswar

7.08.00 **Geotechnical Investigation Scheme**

a) Boreholes (Minimum)

S.No	Structure	Spacing/Number of borehole	Depth of borehole	Remarks
1	Main power house, Turbo-Generator (TG)	35 to 45 m along the rows of main power house columns. Minimum 2 boreholes under each TG	Depth of boreholes shall be 25m to 30m.	Depth of boreholes shall be as mentioned in column "Depth of Borehole" or 5m continuous in rock with RQD > 50% whichever is earlier.
2	Main Plant structures (Boiler, ESP, Chimney, Mills, Fans etc)	Minimum 3 boreholes under each Boiler, Mill & Bunker, ESP structure and 4 boreholes under Chimney, Minimum 2 boreholes under each ESP Control Room, TPs, Fans and Duct Support.	Depth of boreholes shall be 25m to 30m.	
3	Service Building	Minimum 2 no of boreholes	20 to 25 m	
4	CPU Building	Minimum 2 no of boreholes	15 to 20m	
5	Flue Gas Ducting and Absorber Area (FGD)	Minimum 15 boreholes	20 to 25m	
6	Ash Handling Structures	Minimum 8 boreholes	20 to 25 m	
7	Corridors for Ash pipe routes, Ash Water recirculation pipe routes & Make-up water pipeline	1 borehole @ 500 m c/c along the identified corridor and one ERT shall be conducted near each borehole in Ash Water recirculation pipeline corridor	8-10 m	
8	Crossings along the pipeline corridor like road, river, nallah/	2 no. of boreholes at each crossing (one on each side) and 2 nos (min) of	20 to 30m	

	canal, Approach bridge	boreholes inside the river/ nallah of width more than 10.0m	
9	Air cooled condenser (ACC)	Minimum 10 no of boreholes	25 to 30 m
10	Switchyard	Minimum 10 No of Boreholes and 8 No of ERT	10 to 15 m
11	Coal Handling Plant	Minimum 1 borehole under each TP and 1 under each crusher and 1 borehole under each structure. Minimum 10 no of under each stockpile area, 1 in each WT	20 to 30 m
12	Transformer yard	Minimum 8 boreholes and 8 No of ERT	10 to 15 m
13	Water and effluent treatment and disposal plant	Minimum 6 no of borehole	10 to 20 m
14	AWRS pump house, Control room building, swgr room etc.	4 Nos. boreholes, 3 Nos. ERT and 1 no PLT	
15	Fuel oil unloading and storage system	Minimum 2 Nos.	10 to 20 m
16	Other Structure/Facility	Minimum 2 Nos. boreholes under each area / facility	15 to 20 m
b)	**Other Field Tests (Minimum)**		
1	Plate Load Test (PLT)	2 no in Power House, 3 Nos. in boiler area, 1 No. in CPU, 1 no each in each ESP and 3 Nos. in Ash Handling Structure area in Plant Area, 6 No in Balance of Plant area	Test Depth from 2 to 4 m

2	Cyclic Plate Load Test (CPLT)	1 no in each TG, 1 no in each Mill, 1 no in ID fan, 1 no in each FGD	Test Depth from 2.5 to 4 m	
3	Trial Pit (TP)	About 25 Nos.	Depth - 4 m	
4	In Situ Permeability Test In Boreholes	In minimum 30 Nos. of boreholes	Tests shall be conducted at depths of 1.0m, 3.0m, 5.0m, 8.0m and 10.0m in other than wagon Tippler area. In Wagon Tippler area test shall be conducted at depths of 1.0m, 4.0m,7.0m, 10.0m, 13.0m,16.0m and 20.0m	
5	DCPT	About 10-20% of boreholes up to refusal depth		
6	ERT	6 Nos. in TG/Power House area, 6 nos. in Air cooled condenser, 1 No. in CPU Building, 2 Nos. each in Boiler, Chimney, ESP Control Room, 4 Nos. in Ash Handling Structures area in Plant area, 2 Nos in each FGD. 1No near each Pump House other than mentioned above		
7	CROSS-HOLE TEST	1No. in each TG, 1No. in each Mill & bunker and 2 Nos in ID Fan, 1 no in each FGD	Depths covering from 1.0 m to 15.0 m	
8	PMT	80 no of tests in power house area, SG area & Balance of Plant area	Depths covering from 1.0 m to 20.0 m	

- Depth and location of Boreholes and other field tests (DCPT, PLT, CPLT, Cross-Hole Test, ERT, PMT, field permeability tests etc.) shall be approved by Owner before execution of geotechnical investigation work.

Investigation in any other building / structure / facilities / trestles and associated works / items, which are not listed above shall also be carried

8.00.00	**GENERAL SPECIFICATION**
8.1.0	**General Requirements**
8.1.1	**Joints in Concrete Structures**
	Construction Joints
	All horizontal construction joints shall be provided with a groove (shear key) for transfer of shear force.
	For construction joint in concrete wall, the maximum height of any lift should not exceed 2 meters. However, the time interval between the successive lifts should be as small possible and the wall should be built to its full height in the least possible time.
	Construction/ Expansion joints for all underground structures shall be made water tight by using ribbed PVC water stops with central bulb or of kicker type. The thickness and width of PVC water stops shall be as per the requirement of design. However, the minimum thickness and width shall be 6mm and 225mm respectively. Two - part polysulphide sealant conforming to IS 12118 shall be used for sealing of joints. Preformed bitumen impregnated fibre board conforming to IS 1838 shall be used as joint filler.
	Expansions Joints
	In case of expansion joints, preformed bitumen impregnated fibre board conforming to IS 1838 shall be used as joint filler. The joints shall be sealed with bitumen sealing compound conforming to IS 1834, however in case of liquid retaining/carrying structures, two parts polysulphide sealant conforming to IS 12118 or silicon sealing compound shall be used.
	IS 3414 shall be followed for details of joints in buildings. 3 mm thick stainless steel strip in matt or buff finish shall be provided over building expansion joints.
8.1.2	**Miscellaneous General requirements**
8.1.2.1	All steel sections and fabricated structures, which are required to be transported on sea, shall be provided with anti-corrosive paint before shipment to take care of sea worthiness.
8.1.2.2	Monorails, monorail girders and fixtures shall be provided, wherever required to facilitate erection / maintenance of equipment.
8.1.2.3	Wherever possible all floor openings shall be provided with 100 mm thick 150 mm high RCC kerb all around.
8.1.2.4	Angles 75 x 75 x 6 mm (minimum) with 8mm dia and 150mm long MS lugs @ 150 c/c shall be provided for edge protection all around cut outs/openings in floor slabs. Angles 50 x 50 x 6mm with effective anchor lugs shall be provided for edges of concrete drains supporting grating/covers, edges of RCC cable / pipe trenches supporting covers/chequered plates/ grating, edges of manholes supporting covers, supporting edges of precast RCC covers and any other place where breakage of corners of concrete is expected.
8.1.2.5	Floor of switchgear room shall be provided with embedded M.S. channel suitable for easy movement of breaker panels.
8.1.2.6	Anti termite constructional measures and chemical treatment measures shall be given to all vulnerable areas susceptible to termite including column pits, wall trenches, foundations of buildings, filling below the floors, etc., as per IS 6313 and other relevant Indian Standards.

8.1.2.7	Trenches located outside the buildings shall project at least 200mm above the finished formation level unless noted otherwise elsewhere in this specification so that no storm water shall enter the trench. The bottom of the trench shall be provided with a longitudinal slope of 1:500.The downstream end of cable trenches shall be connected through pipe drains to the nearby RCC manholes (to convey water from trenches) of storm water drainage system, but avoiding back flow of storm water. The precast covers shall not be more than 300 mm in width and shall not weigh more than 65 kg. Lifting hooks shall be provided in the precast covers. The trenches shall be given a slope of 1 in 250 in the direction perpendicular to the run of the trenches. PVC water stops shall be provided at all expansion joints of all trenches. Trench covers near entry or at road crossings shall be designed for 10 T wheel load at centre. Pre - cast covers shall be designed for central point load of 75 Kgs. R. C. C. cable slits shall be filled with sand after erection of cables, up to top level and covered with pre - cast R. C. C. covers.
8.1.2.8	All steel platforms above grade shall be provided with 100 x 6 thick kick plates at edge of platform.
8.1.2.9	Duct banks consisting of PVC conduits conforming to IS 4985 for cables shall be provided with proper sealing arrangement consisting of fire retardant sealing compound.
8.1.2.10	Independent network of lines for sewerage and drainage shall be provided. Plant effluent shall not be mixed with either storm water or sewage.
8.1.2.11	The sub-grade for the roads and embankment filling shall be compacted to minimum 95% of the Standard Proctor density at Optimum moisture content (OMC.)
8.1.2.12	Detailed scheme for dewatering shall be prepared, wherever required, before starting of deep excavation work. IS 9758 shall be followed as general guidance for dewatering.
8.1.2.13	Structural steel column base plates and bolts, gussets, etc., shall not project above the floor level unless and noted otherwise. These shall be encased by concrete cover up to floor level with concrete grade M 25.
8.1.2.14	Non-shrink flowable grout shall be used for under-pinning work below base plate of columns. Nominal thickness of grout shall be 50 mm. Non-shrink cum plasticizer admixture shall be added in the grout. Crushing strength of the grout shall generally be one grade higher than that of the base concrete. Minimum grade of grout shall be M-30. Grouting of all pockets, blockouts, sleeves and the openings around the embedment, inserts, bolts etc. and under pinning below the base / sole plate shall be with non - shrink flowable grout. Grade of grout shall be one grade higher than concrete. However minimum grade of grout shall be M - 30. However, for equipment foundations, high strength (minimum characteristic compressive strength of 60 N/sq.mm at 28 days) ready mixed non-shrink, chloride free, cement based, free flowing, non-metallic grout as recommended by equipment manufacturer shall be used.
8.1.2.15	Rail-track from transformer yard to unloading bay of Main Power House shall be provided with rigid type RCC foundation. Rail weighing 52 kg/m shall be used.
8.1.2.16	All building shall be design to take care of Rain Water harvesting & ground water recharging.
8.1.2.17	As required suitable steel frames shall be provided around openings in the roof and external walls for mounting exhaust fans.
8.1.2.18	All cable trenches shall be provided with suitable insert plates for fixing support angles of cable trays.

CLAUSE NO.	TECHNICAL REQUIREMENTS
8.1.2.19	All internal cable trenches shall have minimum 6mm thick (o / p) chequered plate covers while external cable trenches shall have pre - cast RCC covers. However, the portion of the cable trench behind and sides of control panel / MCC shall be provided with suitable chequered plate covers as directed by the Engineer.
8.1.2.20	750mm wide x 100 mm thick plinth protection in PCC (M-15) shall be provided around all buildings, pits / sumps, clarifiers, tanks, etc.
8.1.2.21	All masonry walls shall be provided with Damp Proof Course at plinth level.
8.1.2.22	All monorail openings in the walls shall be provided with double plate flush steel door shutters with suitable access platform and ladder as required.
8.1.2.23	Hand rail (of minimum 1m height), size and material to be adopted shall be as per general architectural specification.
8.1.2.24	In all buildings, suitable arrangement for draining out water collected from equipment blow downs, leakages, floor washings, firefighting etc. shall be provided for each floor with suitable floor drains.
8.1.2.25	All cable & pipe routing in outlying area shall be clubbed and shall run over ground on steel trestles or other supporting structures at a height specified elsewhere in this specification except in some localized area (as approved by Employer) where the same can run in trenches. In case cable route is not envisaged in the area, pipe shall be routed on ground over RCC pedestals at a height of not less than 500 mm. All trenches shall be of RCC with removable RCC covers.
8.1.2.26 Cl no 8.1.2.26 deleted	~~Water supply line, drainage & Sewerage line of buildings/ facilities shall be connected with the nearest Employer's water supply & drainage~~ line.
8.1.2.27	Unless specified all sand filling shall be compacted to minimum 80% of the relative density and backfilled earth shall be compacted to minimum 90% of the Standard proctor density at OMC.
8.1.2.28	All buildings shall be provided with peripheral drains by the side of plinth protection for catering to the rain water from roofs and storm water from adjacent area.
8.1.2.29	Minimum 2.0m wide walkway with concrete paving shall be provided connecting all buildings and facilities. The top of walkway shall be minimum 200mm above FGL.
8.1.2.30	For all buildings, finished floor level (FFL) shall be minimum 500mm above finished ground level (FGL).
8.1.2.31 Cl no 8.1.2.31 deleted	~~All underground concrete structures like trenches, substructures of pump houses, all water retaining / carrying structures, etc., shall have super-plasticizer cum water proofing cement additive conforming to IS 9103. In addition, limit on permeability as given in IS 2645 shall also be met with~~.
8.1.2.32	40mm Diameter MS rods as earthing mat, placed at a distance of 1.0m away and at depths between 0.60m and 1.00m shall be supplied and laid all around the periphery of buildings, structures, and out door equipment, as per approved drawings. Riser of 40mm Dia. MS rods and connecting to the above Earthing mat shall also be supplied and laid in position by the Contractor, as per the approved drawings. Raiser shall be laid up to a height of 300 mm above the local Ground level, at each of the columns of the buildings on the outside of the buildings, and minimum 2 (two) numbers of structures and equipment. The contractor shall also supply and lay necessary number of 3.0 m deep 40 mm diameter MS rods Earthing

electrodes and connect electrodes to the Earthing mat, as per the approved drawings and supplying and laying of 40 mm Dia. MS rods for connecting the Contractor's earthing mat with the Employer's earthing mat separately at two locations.

8.1.3 **Acid/ Alkali Resistant Lining**

All structures receiving acid / alkali resistant lining shall be tested for water tightness and made leak proof before lining work.

The acid / alkali resistant lining shall be provided broadly in the areas identified. The Bidder shall give a guarantee for satisfactory functioning of the lining for a period of 36 months from the date of completion of the work or date of handing over the site to the Engineer, whichever is later. The Bidder shall replace / rectify defects is any, observed in the lining to the satisfaction of the Engineer without any extra cost during this period.

8.2.0 **Concrete**

General

a) Concrete work shall be carried out as per IS 456. Mix design concrete shall be used for all areas other than lean concrete work and plain cement concrete where nominal/volume mix can be permitted. Design mix shall be carried out as per IS10262. Specific approval of the Engineer shall be obtained regarding degree of quality control to be adopted for design mix.

b) Minimum grade of reinforced cement concrete for all foundations shall be M25 unless noted otherwise. Minimum grade of concrete for other structures/areas (other than machine foundations) shall be M25 for all superstructure and substructure unless noted otherwise elsewhere in this specification.

c) The minimum grades of concrete for different machine foundations and some of other important structural members shall be as follows:

Sl No	Description	Minimum grade of concrete
i)	TG top Deck / Substructure & Raft	M-35
ii)	BFP foundations (in case of springs supported) / (in case of block foundation)	M-35 / M-30
iii)	ID, FD, PA fan & Mill foundations (block foundations)	M-30

d) Higher grade of concrete than specified above may be used at the discretion of the Bidder.

e) Unless otherwise specified, 20mm and down aggregates shall be used for all structural concrete works. However, 40mm and down aggregates may also be used under special conditions for mass concreting in foundation.

f) For thin concrete sections such as roof slab over profiled metal deck sheets, 12mm and down coarse aggregates shall be used for coarse aggregates.

h) **REINFORCEMENT COUPLERS:**
Reinforcement couplers (mechanical splicing systems with upset parallel threaded couplers) may be used in reinforced concrete works, subject to following conditions:
a. Couplers shall meet the performance requirements of IS 16172:2014 for class H.
i. It shall have minimum tensile strength corresponding to Fe550D which is 600 N/mm2 and failure shall take place outside the length of splice as per clause no 9.2.1 of IS:16174.
ii. Percentage elongation at maximum force in the reinforcing bar outside the length of mechanical splice shall be minimum 3 % before the failure of test piece as per clause no. 9.2.2 of IS:16174.
iii. Slip test value shall not exceed 0.10 mm. as per clause no 9.3 of IS:16174.
iv. Cyclic tensile test corresponding to Fe550D reinforcement bar as per clause no 9.4 of IS:16174.
v. Low cycle fatigue test as per clause no 9.5.1 of IS:16174.
vi. High Cycle Fatigue test as per clause no 9.5.2 of IS:16174.
b. The manufacturer shall mark the coupler in such a way that all finished reinforcement couplers can be traced to the original cast from which they were made along with date of manufacture.
c. Sampling and other requirements of IS 16172:2014 shall be complied with.
d. Each lot shall be supplied with manufacturer's test certificate (MTC) indicating values of tests in line with IS 16172:2014.
e. The minimum clear cover requirements are to be ensured for reinforcement couplers also.
f. The couplers shall be used only at the locations where joint is required as per standard lapping purpose and couplers shall not be used for joining of several cut pieces of reinforcement in a single bar. As a general guideline, the length of the bars in which coupler is to be provided should not be less than 4m. Vendors for the reinforcement couplers shall be subject to the approval of Engineer-In-Charge

g) Minimum 75mm thick lean concrete M-7.5 shall be provided below all other underground structures, foundations, trenches, etc., to provide a base for construction.

Special requirements for concreting of major equipment foundations shall be as given below.

a) **Temperature Control of Concrete**

For top decks of TG & BFPs, the temperature of fresh concrete shall not exceed 25 deg C when placed. For maintaining the temperature of 25 deg C in the top decks of machine foundations, crushed ice shall be used in mixing water.

b) **Admixture**

Plasticizer /super plasticizer admixture shall generally be added to the concrete for promoting workability. In addition, plasticizer/super plasticizer-cum-retarder shall be added to retard the setting time for mass concreting work as required. In case of pumping, suitable pumping additive shall also be added to avoid segregation and increase flowability. The slump shall generally be in the range given below:

Top decks of TG & BFP	-	150 mm to 180 mm
Block foundations	-	100 mm to 150 mm
TG Column	-	100 mm to 150 mm

c) **Form work**

Plywood with film face form work shall be used for the top decks of all machine foundations and also for columns of TG foundation.

d) **Placing of Concrete**

Base Raft and top deck of machine foundations shall be cast in a single pour.

e) **Ultrasonic Testing**

Ultrasonic pulse velocity test shall be carried out for TG top deck including TG Columns & BFP top decks (in case of Block type, UPV testing is not required) to ascertain the homogeneity and integrity of concrete. In general, grid spacing of 1.0m to 1.5m may be adopted for carrying out the UPV testing. In addition, additional cubes (at the rate of one cube per 150 cu.m. of concrete subject to a minimum of six cubes) shall be taken to carry out Ultrasonic Pulse velocity (UPV) testing on the cubes, to serve as reference UPV values. Testing shall be done as per IS13311 (Part-1). In case of any defect, the Bidder shall rectify the defects suitably using cement/epoxy grout, etc.

f) **Scheme for Concreting**

Weigh Batching Plants, transit mixer, concrete pump shall be mobilised. Arrangements for standby Plant and Equipment shall also be made.

8.03.0 **Formwork**

Formwork for building RCC Slabs/ Beams & Columns shall be of 2 different types.

Type 1 Formwork: (For RCC slab of Structural Steel Framed Buildings Only)

Troughed colour coated metal deck sheets shall be used as permanent shuttering having minimum thickness of 0.80mm. These profiled metal deck sheets shall be fixed to the structural steel secondary beams/ Purlins using Headed shear anchor studs. The detailed material property requirement of metal deck sheet is specified elsewhere in this specification.

The shear anchor studs for fixing metal deck sheet to floor structural beams shall conform to Type-B studs specified in AWS D1.1/D1.1M or equivalent as shear connector of 19mm diameter and 100mm length manufactured from cold drawn round steel bars conforming to the requirement of ASTM A 29, of grade designation 1010 through 1020, of standard quality with either semi-killed or killed, welded by Drawn Arc Stud Welding through metal deck sheet.

The shear anchor studs for fixing metal deck sheet to roof structural purlins shall conform to Type-B studs specified in AWS D1.1/D1.1M or equivalent as shear connector of 16mm diameter and 65mm length manufactured from cold drawn round steel bars conforming to the requirement of ASTM A 29, of grade designation 1010 through 1020, of standard quality with either semi-killed or killed, welded by Drawn Arc Stud Welding through metal deck sheet.

Type 2 Formwork: (For RCC Buildings)

Plywood with film face formwork shall be used for floor & roof slabs, Columns & Beams of all RCC buildings

8.4.0 **Not Used**

8.5.0 **Fencing and Gate**

Fencing

Fencing with gate shall be provided around transformer yard, switchyard area, fuel oil area and other areas wherever necessary due to security, safety, and statutory requirements as per following specifications.

The fencing, with gate (unless specified otherwise) shall comprise of PVC coated G.I. welded wire mesh fencing of minimum 4 mm diameter (including PVC coating) of mesh size 75mmX75mm of height 2.4m above the toe wall with a 600mm high galvanised concertina at the top, such that total fence height of 3.0m above the toe wall is achieved. The diameter of the steel wire for chain link fence (excluding PVC coating) shall not be less than 2.5 mm.

The PVC coated chain link will be stretched by the clips at 0.5m intervals to three strands of galvanised high tensile spring steel wire (HTSSW) of 2.5 mm diameter interwoven with chain link wire mesh and kept under tension which in turn are attached to the fence post with security nuts and bolts. On every fourth post a clamping strip will be threaded through the links of chain link and bolted to the fence post with the help of security nuts and bolts.

Above the chain link a 600mm high tensile serrated galvanised wire (HTSW) concertina made with wire diameter of 2.5mm will be stretched to 6m and attached to two strands of galvanised HTSSW of 2.5 mm diameter by means of clips at 1m intervals. These two HTSSW strands will be attached to the fence posts with 12 mm security fasteners.

All nuts, bolts, fasteners, clamping strips, clamps, clips, etc., shall be galvanised.

All fence posts shall be of 75 x 75 x 6 MS angles spaced at 2.5m c/c distance. All corner posts will have two stay posts and every tenth post will have transverse stay post. Suitable

R.C.C. foundations for the post and stays shall be provided based on the prevailing soil conditions. All posts of fencing shall be painted with chlorinated rubber paint over a suitable primer.

Toe walls either of brick masonry with bricks of minimum 50 kg./sq.cm. crushing strength or of hollow concrete block masonry shall be provided between the fence posts all along the run of the fence with suitable foundation. Toe wall shall be minimum 200mm above the formation level with 50mm thick P.C.C. coping (1:2:4) and shall extend minimum 300mm below the formation level. Toe wall shall be plastered with cement sand mortar (1:6) on both sides and shall be painted with two coats of textured cement point (Sandtax Matt or equivalent) of approved colour and shade. Toe wall shall be provided with weep holes at appropriate spacings.

Gate along fencing

All gates shall be of structural steel of minimum 3.75 metres width for single lane access road and 8.00 m width for double lane access roads. The height of gate shall be same as that of the fence unless noted otherwise. Each gate shall have provision for wicket gate of size 1.0 m x 2.1 m.

The gate frame and post shall be fabricated from medium class MS pipe of nominal diameter not less than 75 mm. The panel plate shall be of minimum thickness 2.5 mm conforming to IS:513.

The gate shall be complete with fabricated hinges, MS aldrops with locking arrangement, tempered steel pivot, guide track of MS tee, bronze aluminium ball bearing arrangement, castor wheel, etc.

8.6.0 **Grating**

All gratings shall be electroforged types. Minimum thickness of the grating shall be 40 mm for indoor installation and 32 mm for outdoor installation. The opening size shall not be more than 30mmx100mm. The minimum thickness of the main bearing bar shall be 5 mm or as per design requirement whichever is higher. All gratings shall be hot dip galvanised at the rate of 610 g. per sq.m. after surface preparation by means of shot blasting.

8.7.0 **Fabrication**

The fabrication shall be done as per fabrication drawing which would clearly indicate various details of joints to be welded, type of weld, length and size of weld.

All steel structures shall be fabricated in factory, transported and erected at site. All factory fabricated structures shall have bolted field connections. Bunker/Hopper segments shall be fabricated in factory, transported and assembled at site.

~~The factory referred above shall be in operation for the last two (2) years from the date of techno-commercial bid opening. The factory shall have the following facilities:~~

~~a) Multi-Axis Drilling Machine(Computer Numeric Controlled)~~
~~b) Quality Set-up for carrying out necessary Non-Destructive Tests like Dye Penetration Tests, Ultrasonic Tests, Radiographic Tests etc.~~
~~c) Heat Treatment facilities~~
~~d) Area for Pre-Assembly bed~~

Coal bunkers with hoppers and chimney flue liners can either be fabricated at factory in segments, transported and welded at site before erection or fabricated at site. For coal bunkers, hoppers and chimney flue liners, to prevent coal dust/fle gas leakages, the applicable field joints shall necessary be welded.
Note: steel structures shall mean Plant and Non plant building structures, Boiler & ESP support structures, CHP structures, AHP structures, Chimney flue liners support platforms & stairs, pipe and cable support structures.

Welding

a) Welding of Structural steel shall be done by an electric arc process and shall conform generally to relevant acceptable standards viz. IS:816, IS:9595, IS:814, IS:2014, IS:4354 and Indian Standard Hand Book for metal arc welding, and other standards, codes of practice internationally accepted. For welding of any particular type of joint, Bidder shall give appropriate tests as described in any of the Indian Standards - IS: 817, IS: 7307 and international standards as relevant.

b) Submerged arc-welding shall be used for welding longitudinal fillet welds (connecting flange with web) and longitudinal / transverse butt joints for fabrication of columns, framing beams and crane girders and all other built-up members, unless manual arc welding is specifically approved by the Engineer. Necessary jigs and fixtures and rotation of structures shall be so arranged that vertically down-hand position of welding becomes possible. 'Open-Arc-Welding' process employing coated electrodes shall be employed for fabrication of other welded connections and field welding.

c) Wherever welding is done for assembling the components of structures, the job shall so positioned that downhand welding is possible.

d) Any structural joint shall be welded only by those welders who are qualified for all welding procedures and positions in such type of joint that is welded.

e) All records for entire welding operations such as welders identification marks, the joints welded by the each welder, the welding procedures adopted, welding machine employed, pre and post heating done and any non destructive test done and stress relieving /heat treatment performed on such joints shall be accessible to the Engineer for scrutiny.

f) In a fabrication of plated columns/beams and built up members all shop splices in each component part shall be done before such component part is welded to other parts of the member. Wherever weld reinforcement interferes with proper fitting between components to be assembled by welding, these welds shall be ground flush prior to assembly.

g) The members to be jointed by fillet welding shall be brought and held as close together as possible and in no event shall be separated locally by more than 3mm. If the local separation is 1.5mm or greater, the fillet weld size shall be increased by the amount of separation.

Edge preparation for welding as per weld joint detail shall be prepared either by machines or by automatic gas cutting. All edges cut by flame shall be ground before they are welded.

Electrodes

a) The electrodes used for welding shall be of suitable type and size depending upon specification of the parent materials, the method of welding, the position of welding and quality of welds desired e.g. normal penetration welds or deep penetration welds. However, only low Hydrogen electrodes shall be used for plate thickness above 20 mm.

b) All low hydrogen electrodes shall be baked and stored before use as per manufacturer recommendation. The electrodes shall be rebaked at 2500C - 3000 C for one hour and later on cooled in the same oven to 1000C. It shall be transferred to an holding oven maintained at 600C - 700C. The electrodes shall be drawn from this oven for use.

c) Where coated electrodes are used they shall meet the requirements of IS:814 and relevant ASME-Sec. Covering shall be heavy to withstand normal conditions of handling and storage.

d) Only those electrodes which give radiographic quality welds shall be used for welds which are subjected to radiographic testing

e) Where bare electrodes are used, these shall correspond to specification of the parent material. The type of flux-wire combination for submerged arc welding shall conform to the requirements of F-60 Class of AWSA-5-17-69 and IS:3613. The electrodes shall be stored properly and the flux shall be baked before use in an oven in accordance with the manufacturer's requirements as stipulated.

f) 308L and 309L electrodes / fillers shall be used for welding of stainless steel to stainless steel and stainless steel to mild steel respectively.

g) Specific approval of the Engineer shall be taken by Bidder for the various electrodes proposed to be used on the work before any welding is started.

Preheating inter-pass temperature and post weld heat treatment.

a) Mild steel plates conforming to IS:2062 and thicker than 20mm, may require preheating of the parent plate prior to welding as mentioned in Table-I.

However, higher preheat and interpass temperatures required due to joint restraint etc. and will be followed as per approved welding procedure. In welding materials of unequal thickness, the thicker part shall be taken for this purpose.

c) Base metal shall be preheated, not withstanding provisions of IS:9595, to the temperature given in Table-1 prior to welding or tack welding. Preheating shall bring the surface of the base metal to the specified preheat temperature and this temperature shall be maintained as minimum temperature while welding is in progress.

TABLE – 1
MINIMUM PREHEAT and INTER PASS TEMPERATURE FOR WELDING

Thickness of thicker part at point of Welding	**Welding using Low hydrogen electrodes or Submerged arc welding**
Upto and including 20mm	None
Over 20mm and upto and including 40m	20 ^{0}C
Over 40mm and upto and including 63mm	66 ^{0}C
Over 63mm	110 ^{0}C

c) Preheating may be applied by external flame which is non-carbonising like LPG, by electric resistance or electric induction process such that uniform heating of the surface extending upto a distance of four times the thickness of the plate on either side of the welding joint is obtained.

d) Thermo-chalk, thermo-couple or other approved methods, shall be used for measuring the plate temperature.

e) All butt welds with plates thicker than 50mm and all site butts weld of main framing beam shall require post weld heat treatment as per procedure given in AWS D-1.1. Post heating shall be done upto 600 deg.C and rate of application shall be 200 deg.C per hour. The post heat temperature shall be maintained for 60 minutes per 2.5cm. thickness. For maintaining slow and uniform cooling, asbestos pads shall be used for covering the heated areas.

Sequence of Welding

a) The sequence of welding shall be carefully chosen to ensure that the components assembled by welding are free from distortion and large residual stresses are not developed. The distortion should be effectively controlled either by a counter effect or by a counter distortion. The direction of welding should be away from the point of restraint and towards the point of maximum freedom.

b) Each case shall be carefully studied before finally following a particular sequence of welding.

c) Butt weld in flange plates and/or web plates shall be completed before the flanges and webs are welded together.

d) The beam and column stiffeners shall preferably be welded to the webs before the web and flanges are assembled unless the web and flanges to the beam or column are assembled by automatic welding process.

e) All welds shall be finished full and made with correct number of runs, the weld being kept free from slag and other inclusions, all adhering slag being removed.

f) Current shall be appropriate for the type of electrode used. To ensure complete fusion, the weaving procedure should go proper and rate of arc advancement should not be so rapid as to leave the edges unmelted.

g) Pudding shall be sufficient to enable the gases to escape from the molten metal before it solidifies.

h) Non-uniform heating and cooling should be avoided to ensure that excessive stresses are not locked up resulting ultimately in cracks.

i) The ends of butt welds shall have full throat thickness. This shall be obtained on all main butt welds by the use of run off and run on pieces adequately secured on either side of main plates. The width of these pieces shall not be less than the thickness of the thicker part joined. Additional metal remaining after the removal of extension pieces shall be removed by grinding or by other approval means and the ends and surface of the welds shall be smoothly finished. Where the abutting parts are thinner than 20mm the extension pieces may be omitted but the end be welded to provide the ends with the required reinforcement.

j) The fusion faces shall be carefully aligned. Angle shrinkage shall be controlled by presetting. Correct gap and alignment shall be maintained during the welding operation.

k) All main butt welds shall have complete penetration and back surface of the weld being gouged out clean before first run of the weld is given from the back. However,

partial penetration butt weld shall be permitted, when specifically shown in the design drawings.

l) Intermittent welds shall be permitted only when shown in the design drawings.

m) The welding shrinkage shall be minimised by adopting the correct welding procedure and method. In long and slender member extra length should be provided at the time of fabrication for shrinkage.

Testing of Welders

All the welders to be employed for the job shall have to qualify the appropriate tests laid down in IS: 817 and IS: 1181 and ASME IX/AWS D1.1. All the necessary arrangements required for the testing of welders are to be provided by the Bidder.

Inspection of Welds

a) **Visual Inspection**

100 percent of the welds shall be inspected visually for external defects. Dimensions of welds shall be checked. The lengths and size of weld shall be as per fabrication drawings. It may be slightly oversized but should not be undersized. The profile of weld is affected by the position of the joint but it should be uniform. The welds should have regular height and width of beads. The height and spacing of ripples shall be uniform. The joints in the welds run shall as far as possible be smooth and should not show any humps or craters in the weld surface. Welds shall be free from unfilled craters on the surface, under-cuts, stages on the surface and visible cracks.

Such inspection shall be done after cleaning the weld surface with steel wire brushes and chisel to remove the spatter metal, scales, slag, etc., If external defects mentioned above are noticed, there is every possibility of internal defects and further radiographic/ultrasonic examination shall be undertaken.

b) **Production Test Plate**

Test plates shall be incorporated on either side of at least one main butt welds of each flange plate and web plate of every main frame columns and crane girder. The weld shall be continuous over the test plate. The test plate extensions of the main plates and shall be fixed so that metal lies in the same direction as that of the main plate. Test plates shall be prepared and tested in accordance with the accepted Standards, in the presence of the Engineer or his authorised representative. Should any of these tests fail, further radiographic examination of the welds shall be done. These tests for test plates and radiographic examination are additional to those contemplated under inspection and testing.

c) **Non-destructive and special testing**

Radiographic / ultrasonic or other non-destructive examination shall be carried out. All tests of welds shall be carried out by the Bidder at his own cost. The cordoning of radiation zone, while Radiography testing is going on, shall be done.

In case of failure of any of the tests, re-testing of the joints shall also be carried out after rectification is done.

d) **Rectification of defective welding work**

Wherever defects like improper penetration, extensive presence of blow holes, undercuts, cracking, slag inclusion, etc., are noticed by visual inspection/other tests, the welds, in such location shall be removed by gouging process. The joints shall be prepared again by cleaning the burrs and residual matters with wire brushes and grinding, if necessary, and rewelded. The gouging shall as far as possible be done using gouging electrodes.

Inspection and Testing

a) **Fillet Welds**

i) All fillet welds shall be checked for size and visual defects.

ii) Macroetch examination on production test coupons for main fillet weld with minimum one joint per built up beam, column and crane girder, etc.

iii) 25% weld length of tension members of crane girder shall be subjected to dye-penetration test.

iv) On all other welds, dye-penetration test on 5% of weld length with minimum 300mm at each location shall be carried out.

b) **Butt Welds**

i) 100% visual examination.

ii) Dye penetration test on all butt welds after back gouging shall be carried out.

iii) Mechanical testing of production test coupons - minimum one joint/built up beam, column and crane girder. The engineer may reduce the frequency of the test, after getting consistently satisfactory results of initial 10 tests.

iv) 100% radiography test on butt welds of tension flange (bottom flange) of crane girder and bunker supporting girders. All other butt welds shall be subjected to radiography test on 10% of weld length of each welder.

c) **Dimensional Tolerance and Acceptance Criteria of Welds**

i) Every first and further every 10th set of identical structure shall be checked for control assembly at shop before erection.

ii) All structures, components/members shall be checked for dimensional tolerance during fabrication and erection as per IS:7215 and IS:12843 respectively.

iii) Dry film thickness after painting shall be checked by using elchometer.

iv) Acceptance criteria of NDTs on welds shall be as per AWS D-1.1 (Dynamically loaded structures - Tension welds).

Correction of Defective Welds

Correction of defective welds shall be carried out without damaging the parent metal. When a crack in the weld is removed magnetic particles inspection or any other equally positive

means shall be used to ensure that the whole of the crack and material up to 25mm beyond each end of the crack has been removed.

Painting

a) Surface treatment and painting before and after delivery to site shall be in accordance with Clause no. 6.4.0 above. All steel structures shall be designed by following basic design criteria in ISO 12944 Part 3. ■

■ However, where it is not feasible to follow the design criteria given in ISO 12944 Part 3 where the steel surface are inaccessible for application of protective coating, corrosion allowance in thickness(over the design thickness) of structural steel members shall be kept except for tubular and hollow sections where ends are completely sealed with end plates.

b) For parts to be bolted, the surfaces in contact shall be provided with ethyl Zinc silicate primer as specified in clause 6.4.3 (a) and shall be free of oil, dirt, loose rust, burrs and other defects, which would prevent proper seating of the parts. For design of friction type bolted joints slip factor for surfaces with ethyl zinc silicate primer as given in IS 4000 shall be considered.

c) Surfaces inaccessible after shop assembly shall receive the full-specified protective treatment before assembly. However, interior surfaces of Box-sections, which are effectively sealed from all ends, need not be painted.

Bolting

The threaded portion of each bolt shall project through the nut by at least one thread. Approved high strength friction grip bolts, preferably the type with indicated load, shall be used where specified and shall be tightened strictly in accordance with the manufacturer's instructions and the relevant regulations.

When connections are made using high strength friction grip bolts the relevant standards shall be observed.

Erection of Structures

All erection work shall be done with the help of cranes, use of derrick is not envisaged.

Erection Marks

a) Erection marks in accordance with fabrication drawing shall be clearly painted on the fabricated steelwork. Each piece shall be marked in at least on two places. Each piece shall also have its weight marked thereon.

d) The centre lines of all columns, elevations and girder bearings shall be marked on the sections to ensure proper alignment and assembly of the pieces at site.

Erection Scheme

a) The Erection Scheme for the erection of all major structures shall be furnished. The erectability of the structure shall be checked by the Bidder before commencement of fabrication work to avoid future modification. The erection scheme shall indicate the approximate weight of the structural members, position of lifting hook, crane boom length, crane capacity at different boom length and at different boom inclination, etc., Bidder shall take up the erection work only after he has obtained the approval of the erection scheme from the Engineer.

b) The erection scheme shall also give details of the method of handling, transport, hoisting, including false work/staging, temporary, bracing, guying, temporary strengthening, etc., It will also give the complete details of the number and capacity of the various erection equipment that will be used such as cranes, winches, etc.,

along with disposition at the time of erection of columns, trusses, etc.

c) The erection of columns, trusses, trestles, portals, etc., shall be carried out in one single piece as far as practicable. No column shall be fabricated and erected in more than 3 pieces. Galleries shall generally be erected as box i.e. the bottom chord and bracings, top chord and bracings, side vertical posts and bracings, end portals and roof-trusses shall be completely welded prior to erection and if required temporary strengthening during erection shall be made. The inside sheeting runners and roof sheeting purlins may be erected individually. When erection joints are provided in columns, their location shall generally be just above a floor level.

8.8.0 Steel Helical Springs and Viscous Dampers Units

8.8.1 General Requirement

This part of the specification covers the requirement for the manufacturing, testing, supply, transport to site, pre-stressing erection, supervision of erection by the vendor, release of pre-stress, alignment, commissioning, etc. of Steel helical springs and viscous dampers units.

The Steel helical springs and viscous dampers units supplied should be of proven make.

8.8.2 Codes and Standards

Some of the relevant applicable Indian standards and codes, etc, applicable to this section of the specification are listed below:

DIN : 4024 Machine foundations; Flexible supporting structures for machine with rotating masses.

DIN : EN 13906-1 Cylindrical helical springs made from round wire and bar: calculation & design.

DIN : 2096 Helical compression springs out of round wire and rod; quality requirements for hot formed compression springs.

ISO : 10816 Criteria for assessing mechanical vibrations of machine.

ISO : 1940 Criteria for assessing the state of balance of rotating rigid bodies.

8.8.3 Design & Supply of Material

i) Supply

Steel helical springs and viscous dampers and associated auxiliaries shall consist of:

(a) Steel helical springs units (fully pre-stressable) and viscous dampers units along with viscous liquid including associated auxiliaries for installation of the spring units and dampers like steel shims, adhesive pads, etc.

(b) Frames for pre-stressing of spring elements.

(c) Suitable hydraulic jack system including electric pumps, high pressure tubes etc. required for the erection, alignment etc., of the spring units. One set of

extra hydraulic jacks, and hand operated pumps shall also be provided.

(d) Any other items which may be required for the pre-stressing, erection, release of pre-stress, alignment, and commissioning of the Steel helical springs and viscous dampers.

ii) Design

The spring units should have stiffness in both vertical and horizontal directions with the horizontal stiffness not less than 50% of vertical stiffness. However, for projects in high seismic zones, the minimum stiffness in horizontal direction shall be reviewed based on the design requirement and in no case it shall be less than 15% of vertical stiffness.

The stiffness should be such that the vertical natural frequency of any spring unit at its rated load carrying capacity is between 2 Hz to 4 Hz. The damper units or spring-cum-damper units should be of viscous type offering velocity proportional damping. The damper units should be suitable for temperatures ranging from 0 to 50°C. The damping resistance of individual damper units should be such that the designed damping can be provided using reasonable number of Units.

The Steel helical spring units and viscous damper units and their housings shall be designed for a minimum operating life of 30 years. Steel helical spring units shall conform to infinite life fatigue load calculations as per DIN EN 13906-1.

8.8.4 Manufacturing & Testing

Complete manufacturing and testing of the Steel helical springs and viscous dampers shall be done at the manufacturing shop of the approved sub vendor / supplier. For this purpose the contractor / sub vendor shall submit the detailed quality plan for approval of engineer and take up the manufacturing / testing after approval of such quality plan. The quality plan shall include

(a) Manufacturing schedule and quality check exercised during manufacturing.

(b) Detail of test to be carried out at the manufacturing shop with their schedule.

(c) Special requirements, if any, regarding concreting of top deck.

(d) Complete step-by-step procedure covering the installation and commissioning of the spring system.

(e) Manuals for erection, commissioning, testing and maintenance of the Steel helical springs and viscous dampers.

(f) A checklist for confirming the readiness of the civil fronts for erection of Steel helical springs and viscous dampers.

(g) Checklist for equipment required at each stage of erection.

(h) Bill of materials and data sheet of various elements such as spring units, viscous dampers, with their rating, stiffness etc. included in the supply.

(i) Bill of material and data sheet for frames for pre stressing, hydraulic jack including electric pump, high pressure tubes, hand operated pump etc., with their rating and umbers.

	(j) Any other details which may be necessary to facilitate design and construction of the foundations / structures.
8.8.5	The Springs shall conform to codes DIN EN 13906-1 and DIN 2096. The quality assurance and inspection procedure shall be finalized on the basis of the above codes and the quality plans be drawn accordingly.
8.8.6	Transportation Steel helical springs and viscous dampers shall be suitably protected, coated, covered, boxed and crated to prevent damage or deterioration during transit, handling and storage at site till the time of erection.
8.8.7	Erection and Commissioning Complete erection and commissioning of the Steel helical springs and viscous dampers including pre-stressing of elements, placing of elements in position, checking clearances on the shuttering of the RCC top deck, releasing of pre-stress in spring elements, making final adjustments and alignments etc. shall be carried out by a specialist supervisor of vendor. The contractor shall guarantee the performance of the Steel helical springs and viscous dampers for 24 months from the date of commissioning of each machine which shall be termed as Guarantee Period".
8.8.8	Supervision The supervision of installation of Steel helical springs and viscous dampers including pre-stressing, placing, releasing and alignment of spring units shall be done by a specialist supervisor of sub vendor / supplier, trained for this purpose.
8.8.9	Realignment of Spring System If any realignment of the Steel helical springs and viscous dampers is required to be done for aligning the shaft or for any other reasons during the first one year of operation from the date of commissioning of the machine, the same shall be done by the contractor.
8.8.10	Acceptance Criteria Stiffness values shall be checked. The permissible deviations shall be as per DIN 2096. Following acceptance criteria shall be followed: General workmanship is being good as recommended by the manufacturer and approved by the Engineer. Tolerances are within the specified limit. Manufacturer's test certificate (MTC) shall be in compliance with the applicable codes / standards. Bought out material is from the approved manufacturer / vendor. Bought out material is matching with the approved sample.

9.00.00 **Architectural Concepts and Design**

9.01.00 For Architectural Concepts and Design refer to 5.00.01 in this specification.

9.02.00 **General Architectural Specifications**

9.02.01 **General**

a) Minimum 1000 mm high (from floor/ roof level) hand railing shall be provided around all floor/roof openings, projections/balconies, walkways, platforms, steel stairs, etc., wherever the height of the building is more than 12m, railing ht to be 1.2m. All handrails and ladder pipes (except at operating floors) shall be 32 mm nominal bore MS pipes (medium class) conforming to IS:1161 and shall be galvanised as per IS : 4736 and finished with suitable paint. All rungs and ladders shall also be galvanised. Minimum weight of galvanising shall be 610 g/sqm. The spacing of vertical posts shall be maximum 1500mm. Two number of horizontal rails shall be provided including the top member. In addition, toe guard/ kick plate of min size 100x6th shall be provided above the floor level.

In Service Building, Administrative Building, Plant Auditorium and Canteen Building RCC stairs and passages/ corridors hand railing with posts shall be made of stainless steel and be 1200mm high. For Atrium areas, same shall be provided with 10mm thick laminated Glass infill panels.

For RCC stairs, passages & Atriums in buildings, around all floor openings at operating floors, 1000 mm /1200mm high hand railing with 32 NB (polished) stainless steel pipe shall be provided. The spacing of vertical posts shall be 1500mm. Two number of horizontal rails shall be provided including the top member.Toe guard and kick plate shall be provided above the floor level.

b) All stairs shall have a maximum riser height of 180mm and a minimum tread width of 275 mm. Minimum clear width of stair shall be 1200 mm unless specified otherwise. For Administration Building& Service Building, stairs width shall be minimum 1500 mm, with Riser 150mm and Tread 300 mm.

c) All buildings having metal cladding shall be provided with a 150 mm high RCC toe kerb at the edge of the floor along the metal cladding. 1000 mm high hand railing shall be provided on this RCC kerb, wherever required from the safety point of view.

d) In all buildings, structures, suitable arrangement for draining out water collected from equipment blowdowns, leakages, floor washings, fire fighting, etc., shall be provided for each floor. All the drains shall be suitably covered with grating or precast RCC panels.

e) RCC staircase shall be provided for main entrance of Turbine building; control tower area and all other RCC construction buildings.

f) Parapet, Chajjas 450mm over window and 600mm door heads, 900mm over rolling shutters, architectural facias, projections, etc., shall be provided with drip course in cement sand mortar 1:3.

g) All fire exits shall be painted with fire resistant paint P.O red/signal red colour shade which shall not be used anywhere except to indicate emergency or safety measure. Fire safety norms shall be followed as per National Building Codes and fire safety requirements for providing fire exits, escape stairs and fire fighting equipment. In

detailing of all buildings, fire safety requirements conforming to IS: 1641 and IS:1642 shall be followed.

h) Ramps & Lifts for physically challenged persons shall be provided for barrier free access to the buildings.

9.03.00 **Water Supply and Sanitation**

9.03.01 Two numbers of roof water tanks (one for storing service water and another for potable water) of adequate capacities depending on the number of users and 8 hours requirement shall be provided for each building and pump house. Polyethylene water storage tanks conforming to IS:12701 shall be used. ~~The tanks shall be complete with all fittings including~~

For Administrative Building, Service Building, Canteen Building, Gate Complex & Time office Building, IT Building , water tank shall be in R.C.C structure with capacity as per National Building Code

Galvanised MS pipe of medium class conforming to IS: 1239 shall be used for internal piping works for service water and potable water supply. The pipes shall be concealed, and painted with anti-corrosive bituminous paint (as per IS: 158) wherever required.

UPVC (conforming to IS 13592) shall be used for sanitary works above ground level.

~~Sand Cast Iron pipes with lead joints conforming to IS: 1729 shall be used for sanitary works above ground level~~. All Buildings shall be designed with Toilets as per NBC norms.

Minimum one number main toilet block for Gents & ladies separately, with required facilities shall be provided on each floor of Service building Administration building and Canteen building. Toilets for physically handicapped shall be provided as mentioned. Attached toilets shall be provided for all senior executive rooms and conference rooms. All other buildings shall have minimum one toilet block each. The facilities provided in the toilet block shall depend on the number of users. However, minimum facilities to be provided shall be as stipulated in subsequent clause. IS:1172 shall be followed for working out the basic requirements for water supply, drainage and sanitation. In addition, IS:2064 and IS:2065 shall also be followed.

9.03.02 Each Toilet block shall have the following minimum facilities. Unless specified all the fittings shall be of Chromium plated brass (fancy type). For GRIHA rated Buildings all fittings shall conform to GRIHA requirements, for water efficiency. The toilet fixtures and facilities shall be as per NBC for Admin, Service, Canteen, Auditorium, IT Building and Time Office

a) One number wall mounted coloured (excluding premium colours) glazed vitreous China European water closet and flushing valve system, water faucet, toilet paper holder as per IS:2556

b) One number colour (excluding premium colours) glazed ceramic oval shaped wash basin 450x 550 mm (approx.) mounted over 18mm thick granite beveled edge counter fitted with photo-voltaic control system for water controls, bottle trap as per IS:2556. For common toilets, number of washbasins shall be as per requirement. However for Pump Houses the same shall be provided without photo voltaic control system for water control.

c) For Male Toilets Urinal as per requirements, with all fittings with photovoltaic control flushing system as per IS:2556.

d) One number looking mirror 600 x 900 x 6 mm, edge mounted with teak beading and minimum 12 mm thick plywood backing, one number stainless towel rail 600 x 20 mm, one number liquid soap dispenser

e) One toilet with required facilities shall be provided for physically challenged persons as per National Building Code requirements

f) In addition to the facilities stipulated elsewhere Bathroom with rotating type chromium plated shower including all fitting and fixtures shall also be provided in toilet at ground and operating floor of main plant:

g) Janitor Space & space for drinking water cooler.

h) Electric operated hand dryer with photo voltaic control.

i) The pantry shall consist of one number stainless steel pantry sink, as per IS : 13983, of size 610 x 510 mm, bowl depth 200 mm with drain board of at least 450 mm length with trap, hot and cold water mixer, one number geyser of 25 liters capacity, with inlet and outlet connections, one number HDPE loft type / over head water storage tank, as per IS : 12701 and of 500 liters capacity, complete with float valve, overflow drainage pipe arrangement, GI concealed water supply pipe of minimum 12 mm dia of medium class, cast iron sanitary pipe (with lead joints) of minimum 75 mm diameter, floor trap with Stainless

Steel grating, inlet and outlet connections for supply and drainage, with all bends, tees, junctions, sockets, etc., as are necessary for the commissioning and efficient functioning of the pantry (all sanitary fittings shall be heavy duty chrome plated brass, unless noted otherwise)

j) Laboratory sink shall be of white vitreous china of size 600x400x200 mm conforming to IS:2556 (Part-5).

k) In addition, adequate number of portable toilet units with adequate plumbing and sanitary arrangement, shall be provided during construction stage.

9.04.00 **Flooring**

Floor finishes of approved shade and colour (~~non – premium colours)~~, over under bed of cement mortar / concrete, at all levels and for all kind of works, elevations, on horizontal and vertical surfaces for all types of work (like flooring, skirting, dado, wall lining & facing, tread and risers etc.), including topping, spreading white cement slurry at an average rate of 2.5 kg/Sq. M., (unless noted otherwise), jointing and joint filling with white cement (unless noted otherwise) slurry mixed with colour pigment, to match the shade of the finishing material, laying to plumb and water level in desired pattern, line and flush butt square jointing, curing, rubbing, grinding, polishing, edge moulding, finishing and cleaning, testing, providing opening of required size and shape, casting in panels wherever specified.

9.04.01 The nominal total thickness of floor finish shall be 50 mm (70 mm) i.e. underbed and topping. The floor shall be laid on an already laid and matured concrete base. The underbed for floors and similar horizontal surfaces shall consist of cement concrete M20 grade. Stone chips shall be 12.5 mm down well graded(& proper filling shall be done with brick bats/cinders). Flooring like Tiles/ Stones shall be laid with 1:4 cement sand mortar and Tile/ Stone Cladding on wall shall be laid with 1:3 cement sand mortar.

9.04.02 Sunken slabs shall be made water tight by suitable water proofing treatment.

9.04.03 Metallic hardener topping -with ordinary grey cement shall be- 12 mm thick (insitu) or finishing the concrete / mortar surfaces topping shall be furnished with neat cement slurry (with ordinary grey cement)

9.04.04 Heavy duty cement concrete tiles 300 mm x 300 mm shall be in using white cement with pigment, with hard and abrasion resistant carborundum / quartz chips for wearing course as per IS:1237. Laying of tiles shall be as per IS:1443.

9.04.05	Heavy duty (grade-5) dust pressed ceramic tiles (300mmx300mm shall be as per IS 15622. Designer ceramic wall tiles of size 300 mm x 200 mm / (300x600mm).
9.04.06	20mm / 38mm / 75 mm/ 115mm thick acid resistant tile on horizontal and vertical surfaces, at all levels for all type of works shall include one coat of bitumen primer followed by 12 mm thick bituminastic layer, 20mm / 38mm/ 75 mm / 115mm thick A.R. tiles, 6 mm thick under-bed by potassium silicate mortar, pointing of joints of tiles with acid/alkali resistant epoxy/furane mortar up to a depth of 20 mm and bituminastic end sealing.

9.4.7 (i) Mirror polished Doubly charged & Matt Finish Vitrified ceramic tiles (minimum 9.5mm thick) with 3mm groove joints as per approved pattern pointed neatly with 3x4mm stainless epoxy grout mix of 0.70Kg of organic coated filter of desired shade (0.10kg of hardener and 0.20kg of resin per kg) with sizes of the tiles shall be as under: a) 600 mm x 600 mm b) 800mm x 800mm
9.4.7 (ii) Anti-Skid Full Body Vitrified Tiles Antiskid, full body Vitrified Tiles of size 600X600X20 mm thick as specified below of approved make, shade, colour and pattern, over under bed of cement mortar / PCC shall be provided in TG Hall flooring at operating level. Full body Vitrified Tiles shall be laid on properly laid leveled floor, with joints 3 to5 mm wide & 8 to10 mm deep & shall be filled with approved Epoxy Grout mix of 0.70 kg of organic coated filler of desired shade (0.10 kg of hardner and 0.20 kg of resin per kg).Full body Vitrified Tiles shall have water absorption less than 0.5%, Modulus of Rupture more than 38N/mm2, Breaking strength more than 7500 N, Moh's scale more than 6, Abrasion resistance less than 144 mm3 and coefficient of friction more than 0.4. Vitrified Tiles shall generally conform to IS:15622

9.04.08	For pathway, chequered and designed concrete tiles minimum 22 mm thick, 200x200 mm size conforming to IS: 13801 of approved shade and colour shall be used. 1000 wide pathways shall be provided for maintenance on rooftops of all buildings.
9.04.09	PVC flooring, wherever used, shall be minimum 2 mm thick (virgin) as per IS: 3462. The laying of flooring shall be as per IS: 5318.
9.04.10	**Epoxy Flooring** Epoxy Flooring shall be provided with surface preparation of concrete substrate with Captive Shot Blasting Machine OR Light Grinding to form the required anchor profile on the floor substrate followed by application of epoxy resin based moisture barrier underlay of 2 mm thickness including filling of saw cut joints with epoxy cementitious resin based moisture barrier underlay as per manufacturer specification. Application of self smoothing epoxy floor topping of epoxy based resin of 2 mm thickness over epoxy resin based moisture barrier underlay including application of solvent free epoxy resin based two component primer. It shall include application of PU Sealant at Expansion and Isolation Joint respectively including surface preparation of the joint, fixing of backup strip and application of sealant.
9.04.11	Wherever required, carpet flooring shall be provided over cement concrete floor as in conference room of main control room complex. The carpet shall be of tile/roll form, machine/hand made tupled un-cut loop pile and lay with under lay of 10mm thick and shall be laid as per manufacturer's recommendations, in matching grains. It shall be treated with anti fungus and anti-termite before laying.
9.04.12	Mirror polished (6 layers of polish) Granite stone (slab) - 18 mm Thk (minimum) / Flame finish/ (making top surface rough by burning)/ honed finish granite stone (slab) - 18 mm Thk (minimum) shall be provided.
9.04.13	~~18 mm thick shall be provided in main stairs & 18mm thick kota stone shall be provided as specified~~.
9.04.14	Decorative/designer prepolished, plain and pigmented, high wearing resistance concrete tiles of 20mm thickness (minimum) in various non-standard interlocking patterns.
9.04.15	Skirting in general shall be 150 mm high. Dado in toilets & pantries, shall be upto height from finished floor level. Skirting and Dado shall match with the floor finish.
9.04.16	Providing and fixing removable raised/false access flooring with system and its components of approved make for different plenum height with possible height adjustment upto 50 mm,

Cl No 9.04.13 Deleted

Up to false ceiling level

comprising of modular load bearing floor panels supported on G.I. rectangular stinger frame work and G.I.Pedestal etc. all complete, as per the architectural drawings, as specified and as directed by Engineer-in-charge consisting of :

a) Providing at required spacing to form modular framework, pedestals made out of GI tube of thickness minimum 2 mm and 25 mm outer diameter, fully welded on to the G.I. Base plate of size 100mm x 100mm x 3mm at the bottom of the pedestal tube, G.I. pedestal head of size 75mmx75mmx3.5 mm welded with GI fully threaded stud 16mm outer diameter with two GI Check nuts screwed on the stud for level adjustment upto 50mm, locking and stabilizing the pedestal head in position at the required level. The pedestals shall be fixed to the subfloor (base) through base plate using epoxy based adhesive of approved make or the machine screw with rawl plug.

b) Stringers system in all steel construction hot dipped galvanized of rectangular size 570x20x30x0.80mm thick having holes at both ends for securing the stringers on to the pedestal head using fully threaded screws ensuring maximum lateral stability in all directions, the grid formed by the pedestal and stringer assembly shall receive the floor panel, this system shall provide adequate solid, rigid support for access floor panel, the system shall provide a minimum clear uninterrupted clearance between the bottom of the floor for electrical conduits and wiring etc. all complete as per the architectural drawings, as specified and as directed by the Engineer-incharge.

c) Providing and fixing Access Floor panel of 600x600x32 mm medium grade Filled Steel anti static high pressure Lamination of 800H grade (FS800H). Access Floor panel shall be steel welded construction with an enclosed bottom pan with uniform pattern of 64 hemispherical cones. The top and bottom plates of Steel Gauges: top 0.6 mm and bottom 0.7 mm fused spot welded together (minimum 64 welds in each dome and 20 welds along each flange). The panel should be Corroresist epoxy coated for lifetime rust protection and cavity formed by the top and bottom plate is filled with Pyrogrip noncombustible Portland cementitious core mixed with lightweight foaming compound. The access floor shall be factory finished with Anti-static High Pressure laminate with Non Warp technology upto 1mm thickness for superior adhesion and Surface flatness within 0.75mm.The panel is to withstand a Concentrated Load of 363 kgs applied on area 25mm x 25mm without collapse in the centre of the panel which is placed on four steel blocks. The panel will withstand and Uniformly Distributed Load (UDL) minimum 1250 kg/sqm and an impact load of 50kg all complete as per the approved manufacturers specification and as per the direction of Engineer-in-charge. All specification must be printed on the side of the panel to ensure the quality of the product.

9.04.17 Interlocking concrete blocks shall be of various sizes and thickness having M 35 grade of concrete and pigmented to specified colours, in different pattern (in different textures chequered or other patterns in indentation for guiding band/s for visually impaired persons) including the preparation of sub base with 20mm thick sand and filling of joints with sand.

9.04.18 Matt finish (with grooves) Porselin tiles (for guiding band/s for visually impaired persons) shall be with 3mm groove joints as per approved pattern pointed neatly with 3X4mm stainless epoxy grout SP- 100 of Laticrete or approved equivalent in approved colour to match colour of tile.

24 mm x 24 mm x 3.8 mm thick (minimum) glass mosaic tiles in decorative murals and pattern.

11 mm thick Laminated wooden flooring shall be provided in VIP area, conference rooms & auditoriums. In Auditorium Wooden Flooring shall be as per acoustical requirement in stage portion.

9.04.19 **Paving**

a) Ground floor of all buildings shall be provided with normal duty paving with 50mm thick metallic hardener floor finish. For details of normal duty paving refer to description elsewhere in this specification.

b) PCC paving of nominal mix M15 grade, 100 mm thick laid over 75 mm thick bed of dry brick aggregate shall be provided for following areas:

i) 750 mm wide plinth protection around all buildings other than those covered under paved area.

ii) 2.0 m wide pathway all along pipe/ cable corridor and all around each cooling tower. 2.0 mm wide ways inter connecting all cooling towers with each other.

9.05.00 **Acid/ Alkali Resistant Lining**

9.05.01 The material shall conform to the following:

i) Bitumen primer shall conform to IS: 158.

ii) Bitumastic compound shall conform to IS: 9510. Where the height of bitumastic layer on vertical surface is more than 2.0 m, the bitumastic layer shall be reinforced with diamond pattern expanded metal steel sheets conforming to IS: 412.

iii) A.R. Bricks/ Tiles shall conform to class II of IS: 4860 & IS: 4457 respectively.

iv) Mortar: Potassium silicate & resin type mortars shall conform to IS: 4832 Part-I&II respectively.

9.05.02 Requirements for acid/ alkali resistant flooring and lining for different areas shall be as given Table-A enclosed at the end of this specification. Battery Room in all buildings shall be provided with acid/ alkali resistant tiles on flooring & dado 1200mm high.

9.06.00 **Roof**

9.06.01 Except for the roofs subjected to heavy loads, roof of all buildings having structural steel frame work shall consist of permanently colour coated (on exposed face) troughed metal sheet decking of approved profile having minimum base metal thickness of 0.8mm of galvanised (with minimum rate of galvanisation of 275 gm/sq.m.) M.S. sheet or minimum 0.8mm of high tensile steel (minimum yield strength 350 MPa) coated with zinc aluminium alloy (zincalume) (coating not less than 150 gm./sq.m). Silicon modified polyester paint having DFT of minimum 20 microns shall be used for permanent coating. The sheeting shall be fixed by means of concealed fixing system or any other compatible method approved by the Engineer. RCC slab of minimum 40 mm clear thickness in excess of trough depth shall be provided over the metal decking. Water proofing cum plasticiser compound shall be added to concrete over the metal decking. Bidder shall demonstrate that the roof is leak proof by carrying out the water-retaining test by maintaining the minimum water depth of 50mm over the roof surface for a period of 48 hours. Water Proofing Treatment as given below for RCC roof slabs shall be provided to ensure that the roof is watertight.

9.06.02 Roof of all buildings having RCC framework shall have cast-in-situ RCC slab. Such roof shall be provided with roof water proofing treatment using high solid content liquid applied elastomeric water proofing membrane with separate wearing course as per ASTM - C-836 & 898. Thickness of the membrane shall be 1.5mm (min.). This treatment shall include

application of polymerised mastic over the roof to achieve smooth surface and primer coat. Wearing course on the top of membrane shall consist of 25mm thick PCC (1:2:4) cast in panels of maximum 1.2 x 1.2m size and reinforced with 0.56mm dia galvanised chicken wire mesh and sealing of joints using sealing compound/elastomeric water proofing membrane. However, chequered concrete tile flooring 22 mm (min.) thick of approved colour and shade conforming to IS: 13801 shall be provided for path way of 1 m. width for access of personnel and handling of equipment and for the entire area of the roof where equipment like AC / Ventilation plant, cooling towers, etc. are provided in place of PCC wearing course. Equipment shall be installed on raised pedestal of minimum 30 cm height from the finished roof to facilitate maintenance of roof treatment in future.

9.06.03 For efficient disposal of rainwater, the run off gradient for the roof shall not be less than 1:100 and the roof shall be provided with RCC water gutter, wherever required. Gutter shall be made water tight using suitable watertight treatment. This gradient can be provided either in structure or subsequently by screed concrete 1:2:4 (using 12.5 mm coarse aggregate) and/or cement mortar (1:4). However, minimum 25 mm thick cement mortar (1:4) shall be provided on top to achieve smooth surface.

9.06.04 Medium class galvanized mild steel pipes 150Dia conforming to IS 1239/IS3589 with welded joints shall be provided to drain off rain water from the roof. These shall be suitably concealed with masonry work, cement concrete/ or sheeting work to match with the exterior finish.

~~concrete / or sheeting work to match with the exterior finish~~. The number and size of down comers shall be governed by IS 1742 and IS 2527. Roof drain level of all RCC framed buildings having cast-in-situ RCC roof shall be provided with Rain water gutter and/or 45 x 45 cm size Khurras having minimum thickness of 30 mm with 1:2:4 concrete over PVC sheet of 1 m x 1 m x 400 micron and finished with 12 mm thick cement sand plaster 1:3. All the pipes shall be provided with suitable fittings and fixtures.

9.06.05 Roof of the specific buildings shall conform to minimum 3 star GRIHA Rating shall have Over-deck insulation of minimum 40 mm thick impervious sprayed close cell free rigid Polyurethane foam confirming to IS: 12432 –III, with density of foam 40 TO 45 KG/ cum.Over-deck insulation with 40 mm thk polyurethane foam with density of 40-45 kg/cum shallbe fixed over a coat of polyurethane primer applied @ 6 to 8 sq.m/ litre, laid over cement screed, laid in slope above the cleaned roof top. 400g polythene sheet shall be laid over polyurethane spray and provided with a wearing course of 40 mm thick cement screed1:2:4(1 cement:2 coarse sand:4 stone aggregate 20 mm nominal size) in chequered rough finish, in panels of 2.5mx2.5m and embedding with 24 G wire netting and sealing the joints with polymerized mastic.

Heat resistant tiles of (300mm x300mm x20mm) with SRI (solar Refractive Index)> 78, Solar reflection >0.7 and initial emittance >0.75 on sloped screed surface of terrace at all levels, laid on 20mm thick cement sand mortar in the ratio of 1:4 (1 cement : 4 coarse sand) shall be provided on terraces of GRIHA rated buildings. The joints in the tiles has to be grouted with mix of white cement and marble powder in the ratio of 1:1. The surface shall be rubbed and polished up to three cuts complete. Skirting 150mm along the parapet walls shall be provided in the same manner.

9.06.06 **Roof Water Proofing**

Roof water proofing treatment shall be as follows:

a) For roofs having structural slope:

Top surface of sloped R.C.C. slab shall be finished with 15mm thick cement plaster (1:4). Over the finished surface elastomeric membrane shall be laid. The elastomeric shall comprise of high solid content liquid applied urethane laid over reinforcing layer of polyscrim cloth or non woven geo-textile. The top of the elastomeric membrane shall be finished with 20 mm thick cement: sand (1:4) mortar with chicken wire mesh and pressed precast concrete tiles of 20 mm thickness where applicable shall be laid over mortar at green stage. Provision for thermal expansion of roofing tiles shall be kept by providing an expansion gap in both directions filled up with polysulphide joint sealant. The expansion gap shall be provided in the cement sand mortar underbed layer also.

b) For roofs having no structural slope:

Screed concrete mix (1:2:4) grading having minimum 25mm thickness at the lowest point of the slope shall be laid over R.C.C. slab and shall be laid as per the slope specified elsewhere in the specification. Top surface of grading underbed shall be finished with 15mm thick cement plaster (1:4). Over the finished surface elastomeric membrane shall be laid and top of the elastomeric membrane shall be finished with 20 mm thick cement: sand (1:4) mortar with chicken wire mesh and pressed precast concrete tiles of 20 mm thickness where applicable shall be laid over mortar at green stage. Provision for thermal expansion of roofing tiles shall be kept by providing an expansion gap in both directions filled up with polysulphide joint sealant. The expansion gap shall be provided in the cement sand mortar underbed layer also

9.06.07 Roof of all buildings shall be provided with access/approach through staircase or ladder. Roof where equipment are mounted shall be provided with access through staircase.

9.06.08 RCC parapet wall of minimum 1000 mm height (above top of slab) for all accessible roofs and 600 mm height for all non-accessible roofs shall be provided. Alternatively parapet wall comprising structural steel post, runner and sheeting may be provided for buildings with metal sheet cladding.

9.06.09 Fillets at junction of roof and vertical walls shall be provided with cast-in-situ cement concrete (1:1.5:3) nominal mix followed by 12mm thick 1:4 cement sand plaster.

9.06.10 Pathways for handling of materials and movement of personnels shall be provided with 22mm thick chequered cement concrete tiles as per IS:13801 for a width of 1000mm .

9.07.00 **Walls**

9.07.01 All walls shall be non-load bearing infill panel walls.

9.07.02 For initial height up to 3 metres from ground floor one brick thick masonry wall shall be provided wherever metal cladding is specified.

9.07.03 All internal walls shall be with one brick thick in cement mortar (1:6). However, internal partition walls for toilets shall be with half brick masonry thick with cement mortar (1:4).

9.07.04 For Administration building, Service Building, Auditorium Building and Canteen Building Autoclaved Aerated Concrete blocks shall be used. Autoclaved Aerated Concrete (AAC) block masonry shall be with blocks having dimensions of 625 mm x 250 mm. thickness ranging from 100 mm to 300 mm conforming to I.S. :2185(part-III) .The jointing cement sand mortar in the composition of 1: 6 (Cement: sand) shall be used with suitable plasticizer(optional). Sand having modulus of fineness 1.1 shall be used. The horizontal and vertical joint thickness shall be approximately 10 mm. In case of partition walls (100 mm /125 mm thk.) the joint reinforcement i.e. 1 number of 6-8 mm diameter bars shall be placed at every alternate course to be anchored properly with the main structure. All other structural requirements like stiffening of masonry , joint reinforcement etc. in the AAC masonry work strictly be carried out as per instructions laid down in .I.S 6041 – 1985, I.S -1905.

9.07.05 External wall of control room , control equipment room and ~~ESP building wall~~ shall be of factory made composite modular light weight aerated concrete panels,(minimum 2 hours of fire rating) consisting of 2 fiber reinforced cement sheets (minimum 4 mm thick) on either side of light weight concrete core, having minimum compressive strength of 35 Kg / Cm2 and the density in the range of 700-900 Kg. / cu.m. ~~of the thickness and fire rating as specified below, to provide external wall and internal partition at all levels~~, capable of sustaining wind pressure ~~of 4.50 M height (H)~~ within limiting deflection of span/250, fixed in position in tongue and groove

AC panels shall be minimum 75mm thick and 3.0 M height,

	jointing system by screwing the panels to top and bottom U channels, (channels minimum 1.25 mm thick and galvanised to grade 180 (minimum) as per IS : 277), fixing U profiled top and bottom channels to concrete / primary steel members which are placed at the maximum vertical spacing of 3 m with the help of galvanised steel expansion fasteners, filling the joints from both faces with silicon acrylic paste and making the same water tight by covering with fibre glass tape (minimum 50 mm wide and minimum 0.5 mm thick) or by any other suitable material, so as to ensure that the entire construction done with the light weight aerated concrete panels are weather proof and panel surfaces are flush for painting, creating opening for doors / windows /ventilators / ducts / pipes/fans/AC etc. and finishing the opening face with the same U profiled galvanized steel channel which is used at the top and bottom.
9.07.06	For Main plant building, Control tower and other buildings, the type, thickness and initial height of external cladding facing the transformer yard shall be according to the requirements. External face of Toilets, Air-conditioned and pressurised areas shall be provided with masonry wall as per functional / aesthetic requirements. (Inside the metal cladding wherever provided).
9.07.07	50 mm thick DPC in Cement concrete (1:1.5:3) with water proofing compound followed by two layers of bitumen coating 85/25 grade as per IS:702 @ 1.7 kg./sq.m. shall be provided at plinth level before starting the masonry work.
9.08.00	**COLOUR COATED AND OTHER SHEETING WORK**
9.08.01	**Material** **a) Wall Cladding & Roofing Material** Troughed permanently colour coated sheet of approved shade and colour shall be **i)** either of steel with minimum 0.6mm bare metal thickness (i.e. excluding the thickness of galvanizing/aluminium-zinc coating and painting) of grade G250 as per AS1397 / grade SS255 as per ASTM A653M / grade S250GD as per EN 10326 with zinc coating to class Z275 / aluminium-zinc alloy coating to class AZ150 **ii)** or of minimum 0.5mm BMT (i.e. excluding the thickness of galvanizing/aluminium-zinc coating and painting) of grade G350 as per AS1397 / grade SS340 class 4 as per ASTM A792M / grade S350GD as per EN 10326 with zinc coating to class Z275 / aluminium-zinc alloy coating to class AZ150 **iii)** or of steel of minimum 0.4mm BMT (i.e. excluding the thickness of galvanizing/aluminium-zinc coating and painting) of grade G550 as per AS1397 / grade SS550 as per ASTM A792M / grade S550GD as per EN 10326 with zinc coating to class Z275 / aluminium-zinc alloy coating to class AZ150 Alternatively aluminium feed material of minimum bare metal thickness of 0.7 mm of aluminium alloy of Series 31000 and above as per IS 737 and IS 1254. **b) Metal Deck Roof Material** Troughed permanently colour coated metal decking sheets shall be **i)** either of steel with minimum 0.8mm bare metal thickness (i.e. excluding the thickness of galvanizing/aluminium-zinc coating and painting) of grade G250 as

per AS1397 / grade SS255 as per ASTM A653M / grade S250GD as per EN 10326 with zinc coating to class Z275

ii) or of minimum 0.6mm BMT (i.e. excluding the thickness of galvanizing/aluminium-zinc coating and painting) of grade G350 as per AS1397 / grade SS340 class 4 as per ASTM A792M / grade S350GD as per EN 10326 with zinc coating to class Z275

iii) or of steel of minimum 0.6mm BMT (i.e. excluding the thickness of galvanizing/aluminium-zinc coating and painting) of grade G550 as per AS1397 / grade SS550 as per ASTM A792M / grade S550GD as per EN 10326 with zinc coating to class Z275.

Alternatively aluminium feed material of minimum bare metal thickness of 0.9 mm of aluminium alloy of Series 31000 and above as per IS 737 and IS 1254 can also be used for metal decking.

Thickness tolerance of (+/-) 0.04mm is permissible. However, all design calculations shall be carried out on the basis of lowest value of sheet thickness provided.

9.08.02 **Colour Coating**

Steel shall be colour coated with total coating thickness of at least 40 microns (nominal) comprising of silicon modified polyester (SMP with silicon content of 30% to 50%) paint or Super Polyester paint, of minimum 20 microns (nominal) dry film thickness (DFT) on external face over primer coat of minimum 5 microns (nominal) and minimum 10 microns (nominal) SMP or super polyester paint over primer coat of minimum 5 microns (nominal) on internal face. SMP and Super polyester paint systems shall be of industrial finish of product type 4 of AS/NZ2728.

9.08.03 **Design Criteria**

For wall cladding insulated / uninsulated and conveyor gallery sides and roof, permanently colour coated sheet of troughed profile shall be used. The nominal depth of trough shall be 30 mm. However alternative profile meeting the strength, deflection and other functional requirements such as section modulus and moment of inertia shall be provided.

Sheet shall be of approved profile, sectional properties, colour and shade.

For profiled metal decking sheets (to be used for RCC floor slab **or roof slab**) the sectional modulus and moment of inertia of troughed profile per meter width shall be so as to limit the deflection of sheets to span/250 under total super imposed loading (DL +LL) comprising the self-weight of metal deck sheet, dead weight of green concrete and an additional construction load 100kg per sq.m for two span condition. The section modulus and moment of inertia of troughed profile shall be computed as per the provisions of IS 801 for satisfying the deflection and strength requirements.

For metal deck sheets used for roofing (with or without RCC) and side cladding, the sectional modulus and moment of inertia of troughed profile per metre width shall be such that the deflection of sheets is limited to span/250 under design wind pressure for two span condition. The sectional modulus and moment of inertia of troughed profile shall be computed as per the provisions of IS 801 for satisfying the deflection and strength requirements. No increase in allowable stress is permissible under wind load condition.

9.08.04 **Fasteners**

Side cladding/roofing/decking sheets shall be fixed to the runner/purlins using self-drilling special coated fasteners confirming to corrosion resistant class 3 of AS3566 and tested for 1000 hours salt spray test. Spacing of Self-drilling fasteners in transverse direction (along runners/purlin) shall be equal to the pitch of trough or 250(+/-100) mm, whichever is lesser and in longitudinal direction at every runner/purlin location.

Shear anchor studs shall also be provided through metal deck, which are to be used as permanent shuttering, at regular interval on all top flange / flange plate of structural beams as specified in Clause no. 8.03.00.

Alternatively, J/U type hooks shall be used in roofing which shall be provided in transverse direction (along runners/purlin) at a spacing equal to the pitch of trough or 250(+/-100) mm, whichever is lesser and in longitudinal direction at every runner/purlin location.

9.08.05 **Miscellaneous Details**

To minimize the number of joints, the length of the sheet shall preferably be not less than 4.5m, cut pieces shall not be used, unless specifically approved by the Engineer. However, the actual length shall be such so as to suit the purlin / runner spacing.

Lap between the sheets shall be at least 150mm in the longitudinal direction and at least one crest wide in the transverse direction which shall be properly anchored / fixed with fasteners.

Z spacers if required shall be made of at least 2 mm thick galvanised steel sheet of grade 350 as per IS 277

Sealant used for cladding shall be butyl based, two parts poly sulphide or equivalent approved, non stainless material and be flexible enough not to interface with fit of the sheets

. Filler blocks as a trough filler shall be used to seal cavities formed between the profiled sheet and the support or flashing. The filler blocks shall be manufactured from black synthetic rubber or any other material approved by the Engineer.

For insulation of cladding and other areas, mineral wool conforming to IS 8183 shall be used. The density shall be 32 or 48 kg. /cu.m for glass or rock wool respectively. The nominal thickness of insulation shall be 50mm.

All flashings, trim closures, caps etc. required for the metal cladding system shall be made out of plain sheets having same material and any weather/moisture sealants with appropriate material and coating specification as mentioned above for the outer face of the metal cladding. Overlap shall be min. 150 mm or as specified by manufacturer.

The contractor shall prepare working drawings of sheeting system including end and side laps, flashing, fixing details etc. before starting sheeting work at site.

9.08.06 **Pre-Fabricated Insulated Metal Sandwich Panels**

For buildings where Pre-Fabricated Insulated Metal Sandwich Panels shall be used for Roofing, the sandwich panels shall comprise top sheet as troughed permanently colour coated sheet & bottom sheet as plain permanently colour coated with 50mm thick insulation sandwiched between the two sheets. Each sheet shall be

i) either of steel with minimum 0.6mm bare metal thickness (i.e. excluding the thickness of galvanizing/aluminium-zinc coating and painting) of grade G250 as per

AS1397 / grade SS255 as per ASTM A653M / grade S250GD as per EN 10326 with zinc coating to class Z275 / aluminium-zinc alloy coating to class AZ150

ii) or of minimum 0.5mm BMT (i.e. excluding the thickness of galvanizing/aluminium-zinc coating and painting) of grade G350 as per AS1397 / grade SS340 class 4 as per ASTM A792M / grade S350GD as per EN 10326 with zinc coating to class Z275 / aluminium-zinc alloy coating to class AZ150

iii) or of steel of minimum 0.4mm BMT (i.e. excluding the thickness of galvanizing/aluminium-zinc coating and painting) of grade G550 as per AS1397 / grade SS550 as per ASTM A792M / grade S550GD as per EN 10326 with zinc coating to class Z275 / aluminium-zinc alloy coating to class AZ150.

Alternatively aluminium feed material of minimum bare metal thickness of 0.7 mm of aluminium alloy of Series 31000 and above as per IS 737 and IS 1254.

Metal sheets (steel or aluminium) shall be colour coated with total coating thickness of at least 40 microns (nominal) dry film thickness (DFT) comprising of Silicon Modified Polyester (SMP with silicon content of 30% to 50%) paint or Polyester paint, of minimum 20 microns (nominal) SMP or polyester paint on one side (exposed face), over minimum 5 micron (nominal) primer coat and minimum 10 micron (nominal) SMP or Polyester paint over minimum 5 micron (nominal) primer coat on other side. SMP and Super Polyester paint shall conform to product type 4 of AS/NZS 2728. Troughed sheet shall be of approved profile, sectional properties, (suitable for the specified loading / deflection and purlins / runners spacing), colour and shade.

Special coated fastener conforming to corrosion resistant Class 3 of AS3566 and tested for 1000 hours salt spray test shall be used for fixing Pre-Fabricated Insulated Metal Sandwich Panels with the structural members below.

The contractor shall prepare working drawings of sheeting system including end and side laps, fixing details etc. before starting sheeting work at site.

9.08.07 **Polycarbonate Sheets**

The polycarbonate sheet to be used for cladding and glazing purpose in conveyor galleries, Transfer points & pump houses shall have toughed profile to match with the metal cladding profile. Minimum 3.0mm thick fire retardant and UV resistant polycarbonate clean sheet of approved make shall be used. The polycarbonate sheet shall be installed along with the metal cladding so as to have a watertight lapping arrangement. Suitable detailing shall be made to cater for the thermal expansion. IS 14434 to be referred for other details.

9.09.00 **Plastering**

9.09.01 Outer face (i.e. rough side) of all brick walls shall have 18 mm thick and inner face (i.e. smooth side) of all walls shall have 12 mm thick cement sand plaster 1:6.

9.09.02 Acrylic wall putty in two coats shall be applied over cement plastered surfaces in interior of building.

~~punning over cement plastered surfaces~~. The finish surface shall be smooth and shall be of 2 mm nominal thickness.

9.09.03 All R.C.C. walls shall have minimum 12mm thick cement sand plaster 1:6.

9.09.04 All RCC ceilings (except areas provided with false ceiling, cable vault ceiling and metal decking) shall be provided with 6mm thick cement sand plaster 1:4.

9.09.05 Groove of uniform size 12 x 12 mm up to 20 x 15 mm in plastered surface as per approved pattern, shall be provided as per approved drawing.

CLAUSE NO.	TECHNICAL REQUIREMENTS
9.09.06	All plastering work shall conform to IS:1661.
9.10.00	**Painting & Aluminium Composite Panel Cladding**
9.10.01	All painting on masonry or concrete surface shall preferably be applied by roller. If applied by brush then same shall be finished off with roller.
9.10.02	All paints shall be of approved make including chemical resistant paint.
9.10.03	Minimum 2 finishing coats of paint shall be applied over a coat of primer.
9.10.04 Cl No 9.10.04 Deleted	~~Solvent based (100% pure acrylic co-polymer resin based) paint shall not contain any water sensitive ingredients. Paint shall be applied in two or more coats as required on an under coat of suitable primer or one coat of cement paint on the new plastered surfaces inclusive of required tools, material and other painting accessories etc. The paint is to be applied as per the specifications, instructions and satisfaction of Engineer-in-charge.~~
9.10.05	Stone work for wall lining etc. (Veneer work) over 20 mm thick bed of cement mortar 1:3 (1 cement: 3 coarse sand) and jointed with grey cement slurry @3.3kg/sq.m, including rubbing and polishing in complete. (Black polished granite stone slab, 18 mm thk / polished Sadarhally grey granite slab 18 mm thk). The final, finished coating shall be fungus resistant, UV resistant, water repellant, alkali resistant, and extremely durable with colour fastness.
9.10.06	Acrylic emulsion paint shall be as per IS:15489. Acrylic distemper shall be as per IS:428. Cement paint shall conform to IS:5410, white wash/colour wash shall conform to IS:627.
9.10.07 Cl No 9.10.07 Deleted	~~Fire resistant transparent paint as per IS:162 shall be provided on all wood work over French polish or flat oil paint. French polish shall conform to IS:348. Flat oil paint shall conform to IS:137~~.
9.10.08	All fire exits shall be painted in post office red/signal red colour shade, which shall not be used anywhere else except to indicate emergency or safety measure.
9.10.09	For painting on concrete, masonry and plastered surface IS:2395 shall be followed. For painting on wood work IS:2338 shall be followed.
9.10.10	For painting on steel work and ferrous metals, BS: 5493 and IS:1477 shall be followed. The type of surface preparation, thickness and type of primer, intermediate and finishing paint shall be according to the painting system adopted.
9.10.11	Bitumen primer used in acid/alkali resistant treatment shall conform to IS:158.
9.10.12	All internal paints shall be of low VOC content conforming to GRIHA rating for reduction of VOC content.
9.10.13 Cl No 9.10.13 Deleted	~~Resin bonded granular textured finish, for external applications shall consist of crushed stone / quartz chips of 2.5 mm size and of approved colour/ shade and bonded with synthetic resins, Adhesives and additives, all together in a single pack mix. For internal finish 1.2mm of approved, colour & shade (pigmented granular or flake finish)~~ The final finish shall have UV-Resistant, fungus/bacterial resistant properties. Grooves shall be provided as per drawing and the same shall be filled with polysulphide sealant of matching colour/shade.

9.10.14

Aluminium Composite Panel

Aluminum Composite Panel cladding with open grooves shall be designed, fabricated, tested installed and fixed for linear as well as curvilinear portions of the building for all heights and levels including:

a) Structural analysis & design and preparation of shop drawings for pressure equalization or rain screen principle as required, proper drainage of water to make it watertight including checking of all the structural and functional design.

b) **Aluminium Composite Panel cladding in pan shape in metallic/ solid colour of approved shades made out of 4mm thick aluminium composite panel. ACP consisting of 3mm thick Fire Retardant mineral filled Core comprising of around 70% Inorganic compound which is 100% non-combustible mineral and balance 30% is food grade virgin polymer sandwiched between two Aluminium sheets (each 0.5mm thick). The aluminium composite panel top and bottom skin should confirm to Aluminium Alloy 5005 (AlMg 1) marine grade series and H 22/24 temper.**

The ACP sheet shall be coil coated with Kynar 500 based (70:30 ratio) PVDF / Lumiflon based fluoropolymer resin coating of approved colour and shade on face # 1 and polymer (Service) coating on face # 2 as specified using stainless steel screws, nuts, bolts, washers, cleats, weather silicone sealant, backer rods etc.

c) The fastening brackets of Aluminium alloy 6005 T5 / MS with Hot Dip Galvanised with serrations and serrated washers to arrest the wind load movement, fasteners, SS 316 Pins and anchor bolts of approved make in SS 316, Nylon separators to prevent bi-metallic contacts all complete required to perform as per specification and drawing .

Exterior Painting on Wall (Premium Acrylic Smooth Exterior Paint with Silicone Additives)

The paint shall be (premium acrylic smooth exterior paint with silicone additives) of approved brand and manufacture. This paint shall be brought to the site of work by the contractor in its original containers in sealed condition. The material shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fortnight's work. The materials shall be kept in the joint custody of the contractor and the Engineer-in-Charge. The empty containers shall not be removed from the site of work till the relevant item of work has been completed and permission obtained from the Engineer-in-Charge.

Preparation of Surface

For new work, the surface shall be thoroughly cleaned off all mortar dropping, dirt dust, algae, fungus or moth, grease and other foreign matter of brushing and washing, pitting in plaster shall make good, surface imperfections such as cracks, holes etc. should be repaired using white cement. The prepared surface shall have received the approval of the Engineer in charge after inspection before painting is commenced.

Application of Base Coat

Base coat shall be of water proofing cement paint.

Preparation of Mix for Base Coat

Cement Paint shall be mixed in such quantities as can be used up within an hour of its mixing as otherwise the mixture will set and thicken, affecting flow and finish. Cement Paint shall be mixed with water in two stages. The first stage shall comprise of 2 parts of cement Paint and one part of water stirred thoroughly and allowed to stand for 5 minutes. Care shall be taken to add the cement Paint gradually to the water and not vice versa. The second stage shall comprise of adding further one part of water to the mix and stirring thoroughly to obtain a liquid of workable and uniform consistency. In all cases the manufacturer's instructions shall be followed meticulously.

The lids of cement Paint drums shall be kept tightly closed when not in use, as by exposure to atmosphere the cement Paint rapidly becomes air set due to its hygroscopic qualities. In case of cement Paint brought in gunny bags, once the bag is opened, the contents should be consumed in full on the day of its opening. If the same is not likely to be consumed in full, the balance quantity should be transferred and preserved in an airtight container to avoid its exposure to atmosphere.

Application of Base Coat

The solution shall be applied on the clean and wetted surface with brushes or spraying machine. The solution shall be kept well stirred during the period of application. It shall be applied on the surface which is on the shady side of the building so that the direct heat of the sun on the surface is avoided. The method of application of cement Paint shall be as per manufacturer's specification. The completed surface shall be watered after the day's work. The second coat shall be applied after the first coat has been set for at least 24 hours. Before application of the second or subsequent coats, the surface of the previous coat shall not be wetted.

For new work, the surface shall be treated with three or more coats of water proof cement Paint as found necessary to get a uniform shade.

Precaution

Water proof cement Paint shall not be applied on surfaces already treated with white wash, colour wash, distemper dry or oil bound, varnishes, Paints etc. It shall not be applied on gypsums, wood and metal surfaces. If water proofing cement is required to be applied on existing surface, previously treated with white wash, colour wash etc., the surface shall be thoroughly cleaned by scrapping off all the white wash, colour wash etc. completely. Thereafter, a coat of cement primer shall be applied followed by two or more coat of water proof cement.

Application of exterior paint

Before pouring into smaller containers for use, the paint shall be stirred thoroughly in its container, when applying also the paint shall be continuously stirred in the smaller containers so that its consistency is kept uniform. Dilution ratio of paint with potable water can be altered taking into consideration the nature of surface climate and as per recommended dilution given by manufacturer. In all cases, the manufacturer's instructions & directions of the Engineer-in-charge shall be followed meticulously.

The lids of paint drums shall be kept tightly closed when not in use as by exposure to atmosphere the paint may thicken and also be kept safe from dust. Paint shall be applied with a brush on the cleaned and smooth surface. Horizontal strokes shall be given, First and vertical strokes shall be applied immediately afterwards. This entire operation will constitute one coat. The surface shall be finished as uniformly as possible leaving no brush marks.

9.11.00	**Doors & Windows**
9.11.01	Doors, windows and ventilators of air-conditioned areas, entrance lobby of all buildings (where ever provided), and all windows and ventilators of all buildings (unless otherwise mentioned) shall have, electro colour dyed (anodised with 15 micron coating thickness) aluminium framework with glazing. All doors of toilet areas shall be of steel framed solid core flush shutter. For Mill Bunker Building, transfer points, crusher house, conveyor gallery, steel louvered windows shall be provided.
9.11.02	Main entrance of the common control room and control equipment room of MPH shall be provided with air-locked lobby with provision of double doors. Automatic Sliding Doors with Fire Resistant glass shall be provided. Control Rooms of all other buildings shall be provided with Aluminium Glazed door.
9.11.03	Single glazed panels with aluminium framework shall be provided as partition between two air-conditioned areas wherever clear view is necessary.
9.11.04	a) The doors frames shall be fabricated from 1.6 mm thick MS sheets and shall meet the general requirements of IS:4351. b) All steel doors shall consist of double plate flush door shutters. The door shutter shall be 35 mm (min.) thick with two outer sheets of 1.2 mm rigidly connected with continuous vertical 1.0 mm stiffeners at the rate of 150 mm centre to centre. Side, top and bottom edges of shutters shall be reinforced by continuous pressed steel channel with minimum 1.2 mm. The door shall be sound deadened by filling the inside void with mineral wool. Doors shall be complete with all hardware and fixtures like door closer, tower bolts, handles, stoppers, aldrops, locks etc.
9.11.05	Steel windows and ventilators shall be as per IS:1361 and IS:1038.
9.11.06	Wherever functionally required Rolling shutter (fully closed/partly grilled) with suitable operating arrangement (manual/Electric) shall be provided to facilitate smooth operations. Rolling shutters shall conform to IS:6248. M.S sliding doors with suitable mechanical and electrical operations fixtures as per requirement for bigger openings shall be used.
9.11.07	All windows and ventilators on ground floor of all buildings shall be provided with suitable Aluminium grill.
9.11.08	Fire-Proof doors with panic devices shall be provided at all fire exit points as per requirements. These doors shall generally be as per IS:3614 Part-II. Fire rating of the doors shall be of minimum 2 hours. These doors shall be double cover plated type with mineral wool/wood insulation.
9.11.09	Hollow extruded section of minimum 2 mm wall thickness as per IS:1285 shall be used for all aluminium doors, windows and ventilators.
9.11.10	Minimum size of door provided shall be 2.1 m high and 1.2 m wide. However for toilets minimum width shall be 0.75 m and office areas minimum width shall be 1.20m.
9.11.111	Electrically operated, self operable/closing, aluminium framed with tinted glass . sliding doors shall be provided at the entrance of all common control rooms, entrance lobby of facility building.
9.11.12	Fire Doors shall be provided in staircases of Service & Admin Building with Fire Resistant glass with suitable fire resistant frame.
	9.11.13 wooden fire door shall be provided in Auditorium Hall

9.12.00	**Glazing**
9.12.01	All windows and ventilators located in fire prone areas shall be provided with minimum 6 mm thick toughened glass conforming to IS:5437.
9.12.02	For single glazed aluminium partitions and doors, 8mm or 10 mm thick clear toughened glass shall be used.
9.12.03 deleted	9.12.03 ~~Ground glass of minimum 4 mm thickness shall be used for all windows/ventilators in toilets.~~
9.12.04	All glazing work shall conform to IS:1083 and IS:3548.
9.12.05	For main plant glazings, 6mm thk clear reflective toughened glass shall be provided. The glass to be used should be from the manufacturers of glass like Saint Gobain (India) or Asahi (India) or equivalent. The glass should be free from distortion and thermal stress. Solar factor 25% or less, Maximum U-value 3.3 W/ SQMK, VLT min 30%: Light reflection internal 10 to 15%, light reflection external 10 to 20 %, shading coefficient (0.25- 0.28)
9.12.06	For glazings of Air Conditioned Buildings Composite double glazing shall be 24mm thick consisting of 6mm thick clear float glass on inner side and 6mm thick reflective toughened glass on outer side. The two glasses shall be separated by 12mm air-gap and hermetically sealed by beading of anodized aluminium with outer edge sealed with silicon sealant. Outer glass of 6mm thickness shall have following technical characteristics: Solar factor 25% or less, Maximum U-value 3.3 W/ SQMK, VLT min 30%: Light reflection internal 10 to 15%, light reflection external 10 to 20 %, shading coefficient (0.25- 0.28) The glass to be used should be from the manufactureres of glass like Saint Gobain (India) or Ashai (India) equivqlent. The glass should be free from distortion and thermal stress. For CER & Control room, Fire resistant glass partition shall be provided. The fire glass panels shall be min 11mm thick clear, toughened, interlayered 120 minute fire rated for both integrity & radiation control (EW120) with min 15 minute full insulation (EI15) , non wired toughened glass complying to BS476 Part22 or (EN-1634-1 :1999). The glass shall be complied to Class 2B2 Category of Impact Resistance to as per EN 12600 safety Glazing Material. The Glass shall have a light transmission ratio of approx. 86% according to EN410 standards and sound reduction of >=37 dB.. The partition frame frame shall be manufactured of 1.6mm thick galvanized steel sheet (zinc coating not less than 120 gm/sqm) pressed to form a profile of section 35 mm x 60 mm on the vertical sides and 50 x 60 mm on the horizontal side suitable for mounting 120 min Fire Rated Glazed Door Shutter. The Frame shall be filled with mineral wool insulation having density min 96kg/m3. The door frame will have a provision of GI anchor fasteners 14 nos (5 each on vertical side and 4 on horizontal side of size M10x80) suitable for fixing in the opening with Factory made template for SS Ball Bearing Hinges of size 100x89x 3 mm for the fixing of fire rated glazed shutter. The frame shall be finished with a approved fire resistant primer or Powder coating of not less than 30 micron in desired shade.
9.12.07	Glass block masonry work with glass blocks of size 190 x 190 x 90 (min), jointed with suitable adhesive complete as per the best construction practices.
9.12.08	For internal glazed partition, 8mm thick clear toughened glass shall be provided.
9.12.09	For Automatic Sliding doors 12 mm thick Toughened glass shall be provided.

9.12.10	Glass to be used in Admin and Service atrium railing shall be Laminated glass with 6mm heat strengthened glass + 1.52mm pvb layer + 6 mm heat strengthened glass of approved make
9.13.00	**False ceiling**
9.13.01	False ceiling of 12.5 mm thick tapered/square edge glass fibre reinforced gypsum board conforming to IS : 2095 having fine texture finish, including providing and fixing of frame work at all levels, for all kind of work, consisting of light weight galvanised steel member (minimum 0.8 mm thick and galvanised as per IS : 277) having maximum grid size of 1200 mm x 600 mm for supporting panels of specified size, suspended from RCC structural steel or catwalkway grid above, with 4 mm (minimum) galvanised wires (rods), with special height adjustment clips, providing angle section of minimum 25 mm width along the perimeter of ceiling, supporting grid system (minimum 0.8 mm thick and galvanised as per IS : 277), expansion fasteners for suspension arrangement from RCC, providing openings for AC ducts, return air grills, light fixtures, etc., all complete. (concealed grid and finished flat seamless and curve shape (dome etc.), finished smooth(seamless) along with the galvanised light gauge steel supporting system laid in profile to suit the profile of dome)
9.13.02	False ceiling of 15 mm thick mineral fibre board, in tile form of size 600mm x 600mm, along with galvanised light gauge rolled form supporting system in double web construction pre painted with steel capping, of approved shade and colour, to give grid of maximum size of 1200x600. as per manufacturers details including supporting grid system, expansion fasteners for suspension arrangement from RCC, providing openings for AC ducts, return air grills, light fixtures, etc., all complete.
9.13.03	False ceiling of 12 mm thk calcium silicate board of 'HILUX' or equivalent with suspension system as per manufacturers details including supporting grid system, expansion fasteners for suspension arrangement from RCC, providing openings for AC ducts, return air grills, light fixtures, etc., all complete. (With concealed grid and finished flat seamless).
9.13.04	S. No. 89 of Amendment 3:Providing and fixing GI Clip in Metal Ceiling System of 600x600 mm module (of Armstrong/ Hunter Douglas/ Durlam make) which includes providing and fixing `C' wall angle of size 20x30x20mm made of 0.5mm thick pre painted steel along the perimeter of the room with help of nylon sleeves and wooden screws at 300mm center to centre, suspending the main C carrier of size 10x38x10mm made of G.I steel 0.7 mm thick from the soffit with help of soffit cleat 37x27x25x1.6 mm, rawl plugs of size 38x12 mm and C carrier suspension clip and main carrier bracket at 1000mm c/c. Inverted triangle shaped Spring Tee having height of 24 mm and width of 34mm made of GI steel 0.45 mm thick is then fixed to the main C carrier and in direction perpendicular to it at 600mm centers with
9.13.05	Pre-Painted Coil coated Steel false ceiling system, at all level, for all kind of works, consisting of 0.5 mm thick galvanised as per IS : 277, along with galvanised supporting steel members exposed faces of galvanised member to be prepainted with regular modified polyester coating / super polyester coating minimum 20 DFT, to form panels of specified size for tile type panels and roll formed stove enamelled 0.6 mm thick steel carrier, for fixing of lineal type panels by clip on arrangement, suspended from RCC slab / structural steel or catwalk way steel channel grid above with 4 mm (minimum) galvanised wires (rods), with special height adjustment clips, providing angle section of minimum 25 mm leg width along the perimeter of ceiling, including all labour, material, supporting grid system (members minimum 0.8 mm thick and galvanised as per IS : 277) anchor fasteners for making suspension arrangement from RCC, providing openings for AC ducts, return air grills, insulation light fixtures, etc., all complete.
9.13.06	Tile type steel false ceiling system in square pattern panels of 600 mm x 600 mm size along with galvanised light gauge rolled form. supporting system in double web 'T' construction with pre-painted steel, with Tee support.

help of suspension brackets. Wherever the main C carrier and spring T have to join, C carrier and spring T connectors have to be used. All sections to be galvanized @ 120 gms/sqm (both side inclusive) Fixing with clip in tiles into spring 'T' with GI Metal Ceiling Clip in plain Beveled edge global white color tiles of size 600x600 and 0.5mm thick with 25mm height, made of G I sheet having galvanizing of 100 gms/sqm (both sides inclusive) and 20% perforation area with 1.8mm dia holes and having NRC of 0.5, electro statically polyester powder coated of thickness 60 microns (minimum), including factory painted after bending and perforation and backed with a black Glass fiber acoustical fleece

9.13.07	Lineal pattern (closed type) of 100 mm nominal width, with carrier support. Metal ceiling as above in lineal/tile shape in stainless steel, bright finish instead of pre-painted coil coated finish.
9.13.08	Additional hangers and height adjustment clips shall be provided for return air grills, light fixtures, A.C. ducts etc.
9.13.09	Suitable M.S. channel (Minimum MC75 with maximum spacing of 1.2 m C/C both ways) grid shall be provided above the false ceiling level for movement of personnel and to facilitate maintenance of lighting fixtures, AC ducts etc.
9.12.10	Underdeck insulation shall be provided on the ceiling (underside of roof slab) and underside of floor slab of air-conditioned area depending upon the functional requirements. This underdeck insulation shall consist of 50mm thk. mineral wool insulation with 0.05 mm thick aluminium foil & 0.6 mm x 25mm mesh wire netting and shall be fixed to the ceiling with 2 mm wire ties.
9.13.11	Suitable cut-outs shall be provided in false ceiling to facilitate fixing of lighting fixtures, AC grills, smoke detectors, etc.
9.14.00	**Interior Design** A comprehensive interior design scheme shall be conceived with the intention of projecting a definite theme and aesthetic appearance to inside working environment. It shall take into account the mutlidisciplinary engineering activities involving power plant technology, and architectural & civil engineering for a smooth control hierarchy and man machine interface. All the design aspects such as flooring, false ceiling, furniture, colour scheme equipment design & layout, illumination, fire fighting, acoustics and ergonomics requirements shall be detailed out so as to present an overall unified aesthetic spatial appearance. The areas to be undertaken for this interior design process shall be control room complex including common control room, computer room, conference rooms and office areas in the main plant building and the following aspects shall be reviewed and evaluated for design. Furniture to be supplied by Bidder for the control room complex shall be as specified under C&I specification. a) Layout, keeping in view the man-machine interface and suitable ergonomic practices. b) Integration of civil engineering with architecture and interior design. c) Illumination levels, noise levels, electromagnetic interference levels, taking into account the equipment and furniture. d) Comfort and safety requirements such as air conditioning, fire fighting, fire escapes, etc. e) Microprocessors based control system to control the functional requirements. The above design philosophy put into practice shall be detailed out through presentation drawings, perspective views, scale models, detail drawings, etc.
9.15.00	**Stainless Steel Hand railing** Providing and fixing knockdown railing system comprising of SS 304 Grade Stainless Railing of 50mm dia handrail fixed on 50 mm SS round baluster placed at maximum 1000 c/c along

with three numbers 19 mm dia midrail connected at side of baluster by special brackets, both the end of mid rail should be bush inserted for jointing and to give extra strength (joints should not be welded and invisible). The balustrade should be fixed onto floor with casted plate of minimum 6mm thickness. Base plate shall be concealed with suitable SS 304 cover cap so that the mounting height fasteners are not visible after installation. Only high strength anchor fasteners would be used for fixing of baluster, as giving extra strength, rust proof and more durable. Onsite welding is strictly not allowed. Wherever welding is required, it should be Tig welding process with same grade 304/316 at factory only so that floor stone and other things would not be damaged and for safety purpose also. Baluster and handrail connector should be screwed tightened and not to be welded on site. Railing should be tested for appropriate load testing criteria as per international railing standard from EXOVA. Wall thickness of all pipes shall be taken as 2 mm. Along with all visible components developed in high grade SS and whenever required, joints to be filled with bushings for extra strength. Railing Height to be taken @ 1000/ 1200 mm from floor level.

9.16.00 **Finishing Schedule**

Interior and Exterior Finishes shall be as given in Tables-B & C respectively attached at the end of these specification.

TABLE – A
PROPOSED ACID /ALKALI RESISTANT TREATMENT

S.NO.	AREA	PRIMER (ONE COAT)	TYPE OF LINING AND THICKNESS				EPOXY COATING (TWO COATS)
	EFFLUENT TREATMENT PLANT		A.R. BRICKS	A.R. TILES	EPOXY MORTAR	BITUMASTIC	
1	CPU: a) Neutralisation Pit i) Floors	Bitumen	75 mm thick			18 mm thick	
	ii) Walls	Bitumen	115 mm thick			18 mm thick	
	iii) Ceiling	Epoxy					150 micron
	iv) Pillasters		115 mm thick				
	b) Effluent Drains	Bitumen		38 mm thick		12 mm thick	
	c) Floor around equipment & dado	Bitumen		38 mm thick		12 mm thick	
	d) Regeneration area floor & dado	Bitumen		38 mm thick		12 mm thick	

	e) Acid / Alkali storage area	Bitumen		75 mm thick		12 mm thick	
	f) Degasser area floor	Bitumen		38 mm thick		12 mm thick	
	g) Pedestals for supporting equipment	Bitumen		38 mm thick		12 mm thick	
	h) M.S. Grating / Chequered plate	Epoxy					150 micron

Note : -

1. The above table is for general guidance only, however, actual areas/ facilities to be covered shall be as per Scope of work.
2. Suitable end sealing shall be provided.
3. Structures shall be tested for waterproofing before application of Acid / Alkali Resistant Treatment.
4. This treatment shall be applied on dry surface.
5. For laying of AR bricks / tiles, the bedding mortar shall be of potassium silicate 6 mm thickness and the pointing mortar shall be of Epoxy / furane 20 mm deep and 6 mm thickness.

TABLE –B

INTERIOR FINISHING SCHEDULE

S.NO.	DESCRIPTION OF AREA	FLOORING	WALLING	CEILING
1.	Main power house Building.			
	a)Unloading Bay	Cement concrete with Metallic hardener topping	Acrylic distemper	Acrylic distemper (except metal deck area
	b)Cable vault	Cement concrete with Metallic hardener topping	Acrylic distemper	Acrylic distemper (except metal deck area
	c)Balance area including passage	Cement concrete with Metallic hardener topping	Acrylic distemper	Acrylic distemper (except metal deck area
	d)SWAS Room	Vitrified ceramic tiles.	Acrylic emulsion paint.	GI clip in metal false ceiling in combination with GRG plaster border as per design
	e)Equipment Area, ESP SWGR/ ACP Room/ UAF Room	Cement concrete with Metallic hardener topping	Acrylic distemper.	Acrylic distemper (except metal deck area
	f) UPS Battery charger room	Vitrified ceramic tiles.	Acrylic emulsion paint in case of brick wall, Aluminium composite panel cladding on columns and on walls in case of A.C Panels	GI clip in metal false ceiling in combination with GRG plaster board border in column depth or as per approved design
	g)Deaerator floor	Cement concrete with Metallic hardener topping.		-

TABLE –B

INTERIOR FINISHING SCHEDULE

S.NO.	DESCRIPTION OF AREA	FLOORING	WALLING	CEILING
	h) Operating Floor	20 mm thick Heavy duty Anti-skid Full Body Vitrified tiles.	Colour coated Metal cladding on A-Row& Gable end, up to crane girder level.	Metal deck roofing (bottom of sheeting with RAL 9002 finish)
	i) General circulation and movement areas	18mm thk. Polished granite honed finish combination as per design stone / marble stone/ Vitrified Ceramic tiles.		Acrylic distemper (except metal deck area).
	j) Switchgear room	Heavy duty tiles (Cement Concrete tiles 300mmx300mm)	Acrylic distemper	Acrylic distemper (except metal deck area)
	k) MCC Room	Heavy duty tiles (Cement Concrete tiles 300mmx300mm)	Acrylic distemper	Acrylic distemper (except metal deck area)
	l) Control room area including control room, computer room,	Vitrified ceramic tiles	Partition in fire rated glass with fire rated frames with 2 hr fire rating & Aluminium composite panel cladding for columns and walls	GI clip in metal false ceiling in combination with GRG plaster board border in column depth or as per approved design

TABLE –B

INTERIOR FINISHING SCHEDULE

S.NO.	DESCRIPTION OF AREA	FLOORING	WALLING	CEILING
	m) control equipment room,	Vitrified ceramic tiles (Matt Finish) Partition	Partition in fire rated glass with fire rated frames with 2 hr fire rating & Aluminium composite panel cladding for columns and walls	GI clip in metal false ceiling in combination with GRG plaster board border in column depth or as per approved design
	n) Conference room, senior executive room.	Vitrified ceramic tiles (Matt Finish)	Partition in fire rated glass with fire rated frames with 2 hr fire rating & Aluminium composite panel cladding for columns and walls	GI clip in metal false ceiling in combination with GRG plaster board border in column depth or as per approved design
	o) Record room	Heavy duty dust pressed ceramic tiles	Acrylic distemper.	GI clip in metal false ceiling in combination with GRG plaster ~~border as per design~~ board border in column depth or as per approved design
	p) Locker room	Heavy duty dust pressed Ceramic Tiles	Acrylic Emulsion Paint	GI clip in metal false ceiling in combination with GRG plaster board border in column depth or as per approved design
	q) Toilet area	Heavy Duty Dust pressed ceramic tiles	Designer ceramic wall tiles up to False Ceiling Height	Calcium Silicate false ceiling.

TABLE –B

INTERIOR FINISHING SCHEDULE

S.NO.	DESCRIPTION OF AREA	FLOORING	WALLING	CEILING
	r) Office Room, Staff Room	Vitrified ceramic tiles.	Partition in fire rated glass with fire rated frames with 2 hr fire rating & Aluminium composite panel cladding for columns and walls	GI clip in metal false ceiling in combination with GRG plaster board border in column depth or as per approved design
	s) Laboratory area	Vitrified Ceramic / Acid/alkali resistant tiles.	Designer ceramic wall tiles up to False Ceiling Height/ Aluminium composite panel cladding for columns and walls in case of A.C Panel	GI clip in metal false ceiling in combination with GRG plaster board border in column depth or as per approved design
	t) RCC Stair case	18mm thick Granite (Polished and honed Finished) stone	Polished Granite Stone up to 1.2m. ht. & Acrylic Distemper Paint over wall putty finish for balance height.	Acrylic Distemper
	u)Lift and Staircase Lobby	18mm thick polished granite stone as pattern.	18mm thick polished granite & glass mosaic tile cladding upto False Ceiling Height	GI clip in metal false ceiling in combination with GRG plaster board border in column depth or as per approved design
	v)Passages and general circulation areas.	18mm thick polished Marble Stone/ granite stone.	Acrylic Distemper / acrylic emulsion paint.	-

TABLE –B

INTERIOR FINISHING SCHEDULE

S.NO.	DESCRIPTION OF AREA	FLOORING	WALLING	CEILING
	w) Battery Room	Acid and alkali resistant tile.	Acid and alkali resistant tile up to 1.2m height and chemical resistant paint for balance height	Chemical Resistant paint except in locations where Metal deck has been provided
	x)Oil canal, oil room, oil purification Tank and other areas where oil spillage is likely to occur.	Oil resistant paint (epoxy based) 150 micron over primer.	As above except oil canal Oil resistant Paint	As above except oil canal.
	y) Pathways including roof area.	22mm thick concrete chequered tiles.	-	-
2.	Service Building/ Admin Building/Auditorium Building			
	a) Entrance Lobbies and Lift areas/Foyer/Exhibition space.	18mm thick polished granite stone as/ pattern.	Textured paint /18mm thick polished granite cladding and glass mosaic tile murals in lift lobby & foyer	GI clip in metal false ceiling in combination with GRG plaster board border in column depth or as per approved design
	b) Conference room, senior executive room.	Laminated wooden fooring	Glazed partition with Aluminium frame/ Acrylic emulsion paint.	Mineral fiber board false ceiling in combination with GRG plaster board false ceiling.

TABLE –B

INTERIOR FINISHING SCHEDULE

S.NO.	DESCRIPTION OF AREA	FLOORING	WALLING	CEILING
	c) Office Room, Staff Room/Library/Canteen.	Vitrified ceramic tiles.	Acrylic emulsion paint./ Designer Glass mosaic tile mural in combination with textured paint in Canteen	Mineral fiber board false ceiling in combination with GRG plaster board false ceiling
	d) Passage	Vitrified ceramic tiles.	Acrylic emulsion paint.	GI clip in metal false ceiling in combination with GRG plaster ~~border as per design~~ board border in column depth or as per approved design
	e) RCC Stair case	18mm thick Granite (Polished and Flame Finished) stone	Glass Mosaic Tile cladding in murals and pattern	Acrylic Distemper.
	f) Toilet/ Pantry/ Kitchen	Heavy Duty Dust pressed ceramic tiles	Designer ceramic wall tiles dado up to false ceiling level	Acrylic distemper in kitchen / Calcium Silicate false ceiling in toilet and pantry
	g) AHU/ A.C. Plant room/MCC Room/Store	Cement concrete with Metallic hardener topping.	Acrylic distemper	Acrylic distemper
	h) Covered parking area	Pavers interlocking cement concrete blocks.	-	-
	i) Pathways including roof area.	22mm thick concrete chequered tiles.		
	j) Green Room	Vitrified ceramic tiles.	Acrylic emulsion paint.	Mineral Fiber Board False Ceiling
	k) Seating Area	Cement concrete with Metallic hardener topping covered with carpet	Wooden paneling as per acoustic requirement.	Gypsum Board False Ceiling /Mineral fiber board false ceiling as per acoustic requirement.

TABLE –B

INTERIOR FINISHING SCHEDULE

S.NO.	DESCRIPTION OF AREA	FLOORING	WALLING	CEILING
	l) Stage	Cement concrete with Wooden flooring as per acoustical requirement	Wooden paneling as per acoustic requirement.	Gypsum Board False Ceiling /Mineral fiber board false ceiling as per acoustic requirement.
	m) Projector room	Heavy duty dust pressed ceramic tile	Acrylic distemper	Acrylic Distemper
3	ESP control building/Air compressor house			
	a) Operating/Maintenance areas	Cement concrete with Metallic hardener topping	Pre color coated metal panel cladding.	Acrylic distemper (except metal deck area)
	b) Office Room, Staff Room	Vitrified ceramic tiles.	Acrylic emulsion paint	Mineral fiber Board False Ceiling
	c) Control Room	Vitrified ceramic tiles.	Acrylic Emulsion paint /Aluminium composite panel cladding on walls and columns in ESP Control Room Building	False ceiling in lineal Metal panel
	d) MCC Room	Heavy duty tiles (Cement Concrete tiles 300mmx300mm)	Acrylic distemper	Acrylic distemper (except metal deck area)

TABLE –B

INTERIOR FINISHING SCHEDULE

S.NO.	DESCRIPTION OF AREA	FLOORING	WALLING	CEILING
	e) RCC Stair case	Flame finish Granite Stone.	Polished Granite stone up to 1.2m.ht. & Acrylic Distemper	Acrylic Distemper (except metal deck area)
	f) Battery Room	Acid, Alkali resistant tile	Acid, Alkali resistant tile 1.2m height / chemical resistant paint above dado	Chemical resistant paint (except metal deck area)
	g) AHU/ AC Plant room/ Cable vault	Cement concrete with Metallic hardener topping	Acrylic Distemper	Acrylic Distemper (except metal deck area)
	h) Toilets	Heavy Duty Dust pressed ceramic tiles.	Designer ceramic wall tiles dado up to false ceiling level.	Calcium silicate false ceiling.
4.	Canteen/ Gate Complex/Fire station/Safety Centre/ FQA Lab			
	a) Reception/Waiting/ Corridors	Granite stone	Textured paint	Acrylic emulsion paint/GI Metal panel false ceiling in Canteen, Gate Complex and safety centre
	b) Office/Guard Room/Conference/Viewing Gallery/ Staff room /Class Room	Vitrified ceramic tiles.	Acrylic emulsion paint	Mineral fiber board false ceiling. Acrylic emulsion paint for Fire station
	c) Detention Room/ Ammunition store/AHU/MCC Room/ Labs	Cement concrete with Metallic hardener topping	Acrylic distemper	Acrylic Distemper

TABLE –B

INTERIOR FINISHING SCHEDULE

S.NO.	DESCRIPTION OF AREA	FLOORING	WALLING	CEILING
	d) Sitting and General Area	Granite stone/Vitrified ceramic tiles.	Designer ceramic wall tiles up to 1.2 m, and Textured Paint for balance height. Glass mosaic tiles murals & Glass blocks for interior purpose in Canteen.	Acrylic distemper/ Gypsum board false ceiling./ Mineral Fiber Board false ceiling in Canteen and Gate complex and acrylic emulsion paint for Fire station
	e) Kitchen, and preparation area	Heavy duty dust pressed ceramic tiles and Granite stone for platform	Designer ceramic wall tiles dado upto 2.1 m. height and Acrylic distemper for balance area height. .	Acrylic distemper
	f) Toilets/ Pantry	Heavy Duty Dust pressed ceramic tiles.	Designer ceramic wall tiles dado up to false ceiling level.	Calcium Silicate false ceiling.
	g) Fire Tender area	Cement concrete with Metallic hardener topping.	Acrylic distemper.	Acrylic distemper.
	h) Stores	Cement concrete with Metallic hardener topping.	Acrylic distemper.	Acrylic distemper.
	i) RCC Stair case	18mm thick polished Marble stone.	Marble stone up to 1.2m.ht. & Acrylic Distemper above.	Acrylic Distemper
5.	CHP Maintenance Building /O&m store/O&M workshop building.			

TABLE –B

INTERIOR FINISHING SCHEDULE

S.NO.	DESCRIPTION OF AREA	FLOORING	WALLING	CEILING
	a) Workshop/stores/dozer shed	Cement concrete with Metallic hardener topping.	Acrylic distemper/ color coated Metal panel cladding	Acrylic distemper (except metal deck area)
	Office Room, Staff Room	Vitrified ceramic tiles.	Acrylic emulsion paint.	Acrylic emulsion paintMineral fiber board false ceiling/ Acrylic distemper
	b) Passages c)	Vitrified Ceramic Tiles	Acrylic distemper	Mineral fiber board false ceiling/ Acrylic distemper
	d) RCC Stair case	18mm thick polished Marble stone finish.	Marble stone up to 1.2m.ht. & Acrylic Distemper above.	Acrylic Distemper
	Toilets	Heavy Duty Dust pressed ceramic tiles.	Designer ceramic wall tiles dado up to 2.1 m Height from FFL..	Acrylic distemper
6.	a) Mill& Bunker building/Track Hooper/T.P./Conveyer's gallery/Crusher			
	a) Mill& Bunker area/Track Hooper area/ T.P. area/Conveyer's gallery area/Crusher area	Cement concrete with Metallic hardener topping	Acrylic distemper on masonry walls/ color coated Metal panel cladding	color coated Metal panel cladding

TABLE –B

INTERIOR FINISHING SCHEDULE

S.NO.	DESCRIPTION OF AREA	FLOORING	WALLING	CEILING
	Toilets	Heavy Duty Dust pressed ceramic tiles and Granite stone in one piece for wash basin platform.	Designer ceramic wall tiles up to 2.1m / ceiling ht. and Acrylic distemper for balance height.	Acrylic distemper
7.	Fire water pump house a)			
	b) Maintenance /Pump floor/PLC	Cement concrete with Metallic hardener topping	Acrylic distemper	Acrylic distemper (except metal deck area)
	c) Control room /PLC.	Vitrified ceramic tiles Epoxy flooring	Acrylic emulsion paint.	Mineral fiber board false ceiling.
	Toilet area	Heavy Duty Dust pressed ceramic tiles.	Designer ceramic wall tiles dado up to false ceiling level.	Calcium silicate false ceiling
8.	Fire water booster water pump house. a)			
	b) Maintenance /Pump floor/PLC	Cement concrete with Metallic hardener topping	Acrylic distemper	Acrylic distemper (except metal deck area)
	c) Control room /PLC.	Vitrified Ceramic Tiles	Acrylic emulsion paint.	Mineral fiber board false ceiling.
	Toilet area	Heavy Duty Dust pressed ceramic tiles.	Designer ceramic wall tiles dado up to false ceiling level.	Calcium silicate false ceiling

TABLE –B

INTERIOR FINISHING SCHEDULE

S.NO.	DESCRIPTION OF AREA	FLOORING	WALLING	CEILING
9.	a) Ash slurry pump house/ Ash water pump house / Silo Area Utility Building / Ash Water recirculation Pump House/ Transport air compressor house/ HCSD pump house/ Ash Dyke Maintenance building.			
	b) Operating/Maintenance areas/ MCC room	Cement concrete with Metallic hardener topping	Acrylic distemper	Acrylic distemper (except metal deck area)
	c) Office Room, Staff Room	Vitrified ceramic tiles.	Acrylic emulsion paint	Acrylic distemper.
	d) Control room	Vitrified Ceramic Tiles	Acrylic emulsion paint	Mineral fiber board false ceiling.
	e) RCC Stair case	Marble stone / Granite stone.	Marble stone / Granite stone up to 1.2m.ht. & Acrylic emulsion paint	Acrylic Distemper.
	Toilet area	Heavy Duty Dust pressed ceramic tiles and Granite stone in one piece for wash basin platform.	Designer ceramic wall tiles up to 2.1m / ceiling ht. and Acrylic distemper over plaster of Paris for balance height.	Acrylic distemper.

TABLE –B

INTERIOR FINISHING SCHEDULE

S.NO.	DESCRIPTION OF AREA	FLOORING	WALLING	CEILING
10.	a) Water & Effluent treatment plant buildings/Switch yard Control Building & Other auxiliary building.			
	b) Workshop/ Operating/Maintenance areas/MCC areas	Cement concrete with Metallic hardener topping	Acrylic distemper	Acrylic distemper (except metal deck area)
	Office Room, Staff Room	Vitrified ceramic tiles.	Acrylic emulsion paint	Mineral fiber board false ceiling.
	c) Control room d)	Vitrified Ceramic Tiles	Acrylic emulsion paint	Mineral fiber board false ceiling.
	e) Acid/Alkali storage area/ CW treatment area/DM plant area/ Regeneration area/ Neutralization pit etc.	Acid, Alkali resistant tile as per requirement.	Acid/Alkali resistant tile as per requirement and chemical resistant paint above dado.	Chemical resistant paint.
	f) RCC Stair case	Marble stone / granite stone.	Marble stone up to1.2 m.ht. & Acrylic Distemper paint.	Acrylic Distemper

TABLE –B

INTERIOR FINISHING SCHEDULE

S.NO.	DESCRIPTION OF AREA	FLOORING	WALLING	CEILING
	g) Toilet area	Heavy Duty Dust pressed ceramic tiles.	Designer ceramic wall tiles up to false ceiling level	Calcium Silicate False Ceiling
11.	a) IT Building			
	b) FMS room/ IT operator room/IT Server Room/Telephone exchange room/Library/ IT Store/UPS Room/FMS Room/IT Kiosk/Cabins/Conference room/Testing & Repair/ Sect./Executive Hall HOD room etc.	Vitrified ceramic tiles.	Acrylic emulsion paint	GI clip in metal false ceiling
	c) Elect. Room/ OFC Cables & terminators/AHU etc.	Cement concrete with Metallic hardener topping	Acrylic distemper	Acrylic distemper
	d) MCC room	Cement concrete with Metallic hardener topping and False Floor	Acrylic distemper	Acrylic distemper
	e) Toilet area	Heavy Duty Dust pressed ceramic tiles.	Designer ceramic wall tiles dado up to false ceiling level.	Calcium silicate false ceiling

TABLE –B

INTERIOR FINISHING SCHEDULE

S.NO.	DESCRIPTION OF AREA	FLOORING	WALLING	CEILING
	f) Battery room	Acid, Alkali resistant tile	Acid/Alkali resistant tile and chemical resistant paint above dado.	Chemical resistant paint.
	g) Entrance/ Reception/ RCC Stair	Granite Stone	Acrylic emulsion paint and Glass Mosaic tiles cladding	GI clip in metal false ceiling
	h) Passages	Granite Stone and Vitrified Ceramic Tiles	Acrylic emulsion paint	GI clip in metal false ceiling

Note :

1. All wall and roof areas above false ceiling shall be plastered.
2. The colour and pattern of finish shall be as per approved details.
3. All materials shall be of reputed and established brand approved by Engineer-in-charge.
4. Wherever alternative materials are specified, the final selection rests with Engineer-in-charge.
5. This finishing schedule shall also be applicable to similar functional areas for all other buildings and facilities.
6. All the finishing materials shall be applied/provided as per manufacturer specification and guidelines under the supervision & guidelines of manufacturer.
7. Requirement given above are suggestive and minimum. Bidder is welcome to suggest alternative scheme conforming to design functional requirement subject to approval of the Engineer-in-charge.

TABLE –C

EXTERIOR FINISHES SCHEDULE

Sl.No.	DESCRIPTION OF AREA	WALL AND PROJECTIONS	SOFFIT OF PROJECTIONS
1.	Main plant building & Fire walls in Transformer yard; Other Auxilliary building in steel framed structure.	Premium Acrylic Smooth exterior paint with silicon additives over suitable primer of Water Proof Cement Paint over plastered surface Approved colour/ colour combination of colour coated metal cladding	Premium Acrylic Smooth exterior paint with silicon additives over suitable primer of Water Proof Cement Paint over plastered surface Approved colour/ colour combination of colour coated metal cladding
2.	Building with concrete frame work, etc.	Premium Acrylic Smooth exterior paint with silicon additives over suitable primer of Water Proof Cement Paint over plastered surface For Service building/ Admin. Bldg. / canteen, gate complex & Auditorium, Aluminium composite Panel Cladding in combination with Premium Acrylic Smooth exterior paint with silicon additives as per drawing	Premium Acrylic Smooth exterior paint with silicon additives over suitable primer of Water Proof Cement Paint over plastered surface over suitable primer of water proof cement paint.

3.	Steel Structure, trestles, etc.	High performance Paint of approved specification and shade.	

NOTE : 1. The colour and pattern of finish shall be as finalized by Engineer.

2. All materials shall be of reputed and established brand approved by Engineer.

10.00.00 MATERIAL SPECIFICATION

10.01.00 **Cement**

Fly ash based portland pozzolana cement conforming to IS:1489 (Part-1) shall be used for all areas other than for the critical structures identified below. Other properties shall be as per IS code.

Ordinary Portland Cement (OPC) shall necessarily be used for the following structures.

a) TG foundation top deck

b) Spring supported decks of all machine foundations such as TDBFP/MDBFP

c) RCC for Chimney shell.

d) NDCT shell and racker columns of NDCT.

The grade of cement shall be Grade 43 for OPC conforming to IS:8112.

In place of fly ash based portland pozzolana cement, OPC mixed with Fly Ash can be used. Batching plant shall have facility for mixing fly ash. Fly ash shall conform to IS:3812(Part I & Part II). Percentage of fly ash to be mixed in concrete shall be based on trial mix. Mix design shall be done with varying percentage of fly ash mix with cement

10.02.00 **Aggregates**

a) **Coarse aggregate**

Coarse aggregate for concrete shall be crushed stones chemically inert, hard, strong, durable against weathering of limited porosity and free from deleterious materials. It shall be properly graded. It shall meet the requirements of IS: 383.

b) **Fine aggregate**

Sand shall be hard, durable, clean and free from adherent coatings of organic matter and clay balls or pellets. Sand, when used as fine aggregate in concrete shall conform to IS : 383. For plaster, it shall conform to IS : 1542 and for masonry work to IS : 2116.

c) Petrographic examination of aggregate shall be carried out by the contractor at National Council for Cement and Building Materials (NCB), Ballabgarh, or any other approved laboratory to ascertain the structure and rock type including presence of strained quartz and other reactive minerals for machine foundations, etc. In case, the coarse aggregate sample is of composite nature, the proportions (by weight) of different rock types in the composite sample and petrographic evaluation of each rock should also be ascertained. While determining the rock type, special emphasis should be given on identification of known reactive rocks like chalcedony, opal etc. The procedure laid down in IS 2430 for sampling of aggregates may be followed.

The laboratory shall determine potential reactivity of the aggregate, which may lead to reaction of silica in aggregate with the alkalis of cement and / or potential of some aggregates like limestone to cause residual expansion due to repeated temperature cycle. If the same is established, the contractor shall further carry out alkali

aggregates reactivity test as per IS 2386 (Pt.VII) and / or repeated temperature cycle test to establish the suitability of the aggregates for the concrete work. The test results, with the final recommendations of the laboratory, as to a suitability of the aggregate, for use in the concrete work for various structures and suggested measures, in case of results are not satisfactory, shall be submitted to the Engineer for his review, in a report form.

In case in the report, it is established, that the aggregates contain reactive silica, which would react with alkalis of the cement, the contractor shall change the source of supply of the aggregate or use low alkali cement as per recommendation or take measures as recommended in the report as instructed by Engineer. In case aggregates indicate residual expansion, under repeated temperature cycle test (from 10o Celsius to 65o Celsius and for 60 temperature cycles) the material shall not be used for concreting of TGs', BFPs', Mills', Fans' and other equipment foundations which are likely to be subjected to repeated temperature cycle. The contractor shall use aggregates free from residual expansion under repeated temperatures cycle test.

10.03.00 **Reinforcement Steel**

/ Grade 500 D

Reinforcement steel shall be of high strength deformed TMT steel bars of grade Fe-500 and shall conform to IS:1786. However, minimum elongation shall be 14.5%.

Mild steel & medium tensile steel bars and hard drawn steel wire shall conform to grade-1 of IS:432 (Part-1) or grade A of IS:2062. Welded wire fabric shall conform to IS:1566.

10.04.00 **Structural Steel**

Structural Steel (including embedded Steel) shall be straight, sound, free from twists, cracks, flaw, laminations and all other defects. Structural steel shall comprise of mild steel, medium strength steel and high tensile steel as specified below.

10.04.01 Mild Steel

a) a)Rolled sections shall be of grade designation E250, Quality A/BR, Semi-killed/ killed conforming to IS 2062. All steel plates shall be of Grade designation E250, Quality BR (fully killed), conforming to IS 2062 and shall be tested for impact resistance at room temperature. Plates beyond 12mm thickness and up to 40mm thickness shall be normalized rolled. Plates beyond 40mm thickness shall be vacuum degassed & furnace normalised and shall also be 100% ultrasonically tested as per ASTM -A578 level B-S2.

b) Pipes shall conform to IS: 1161.

c) Hollow (square and rectangular) steel sections shall be hot formed conforming to IS: 4923 and shall be of minimum Grade Yst 240.

d) Chequered plate shall conform to IS 3502 and shall be minimum 6 mm thick excluding projection. Steel for chequered plate shall conform to grade E250A semi killed of IS: 2062 or equivalent grade conforming to ASTM & BS standards only.

10.04.02 **Medium and High Tensile Steel**

Rolled Sections and plates shall be of grade designation E350 or higher, Quality B0 (Fully killed), conforming to IS 2062. Plates beyond 12mm thickness and up to 40mm thickness shall be normalized rolled. Plates beyond 40mm thickness shall be vacuum degassed & furnace normalised and shall also be 100% ultrasonically tested as per ASTM –A578 level B-S2.

10.05.00 **Bricks**

Only fly ash bricks shall be used in all construction. Bricks shall be table moulded/ machine made of uniform size, shape and sharp edges and shall have minimum compressive strength of **75kg/cm2**. Burnt clay fly ash bricks and fly ash lime bricks shall conform to IS :13757 and IS:12894 respectively. Minimum fly ash content in fly ash based bricks shall be 25%.

10.06.00 **Foundation Bolts**

Material and details of foundation bolts shall conform to IS:5624. Mild steel bars used for the fabrication of bolt assembly shall conform to grade 1of IS432 and/ or grade A of IS:2062. Hexagonal nuts and lock nuts shall conform to IS 1363 & IS1364 upto M36 diameter and IS 5624 for M42 to M150 diameter.

10.07.00 **Stainless steel**

The material specification for stainless steel plates are mentioned in the design concept area of Mill Bunker building.

10.08.00 **Water**

Water used for cement concrete, mortar, plaster, grout, curing, washing of coarse aggregate, soaking of bricks, etc. shall be clean and free from oil, acids, alkalis, organic matters or other harmful substances in such amounts that may impair the strength or durability of the structure. Potable water shall generally be considered satisfactory for all masonry and concrete works, including curing. When water from the proposed source is used for making the concrete, the maximum permissible impurities, development of strength and initial setting time of concrete shall meet the requirements of IS:456.

All materials brought for incorporation in works shall be of best quality as per IS unless specified otherwise.

10.08.00 **Statutory Requirements**

Bidder shall comply with all the applicable statutory rules pertaining to Factories Act, Fire Safety Rules at Tariff Advisory Committee. Water Act for pollution control, Explosives Act, etc.

Provisions of safety, health and welfare according to Factories Act shall be complied with. These shall include provision of continuous walkways along the crane - girder level on both sides of building, comfortable approach to EOT crane cabin, railing, fire escape, locker room for workmen, pantry, toilets, rest room etc.

Provisions for fire proof doors, number of staircases, fire separation wall, lath plastering/encasing the structural members (in fire prone areas), type of glazing etc. shall be made according to the recommendations of Tarrif Advisory Committee.

Statutory clearances and norms of State Pollution Control Board shall be followed.

Bidder shall obtain approval of Civil/Architectural drawings from concerned authorities before taking up the construction work.

11.00.00 **Inspection, Testing And Quality Control**

11.01.00 Sampling and testing of major items of civil works viz. earthwork, concreting, structural steel work (including welding), piling, sheeting, etc. shall be carried out in accordance with the requirements of this specification. Wherever nothing is specified relevant Indian Standards shall be followed. In absence of Indian Standard equivalent International Standards may be used.

The Bidder shall submit and finalise a detailed field Quality Assurance Programme before starting of the construction work according to the requirement of this specification. This shall include frequency of sampling and testing, nature/type of test, method of test, setting of a testing laboratory, arrangement of testing apparatus/equipment, deployment of qualified/experienced manpower, preparation of format for record, Field Quality Plan, etc. Tests shall be done in the field and/or at a laboratory approved by the Engineer. The Bidder shall furnish the test certificate from the manufacturer's of various materials to be used in the construction.

11.02.00 Workmanship and dimensional shall be checked as stipulated below.

12.00.00 **ANNEXURES**

(a) List Of Codes And Standards

All applicable standards, references, specifications, codes of practice, etc., shall be the latest edition including all applicable official amendments and revisions. A complete set of all these documents shall be available at site with Bidder. List of some of the applicable Standards, in original Codes and references is as given in Annexure-a of this specification.

Annexure-(a)

LIST OF CODES AND STANDARDS

Excavation and Filling

IS :2720	Methods of test for soils(relevant parts)
IS:4701	Code of practice for earth work on canals.
IS:9759	Guide lines for dewatering during construction.
IS:10379	Code of practice for field control of moisture and compaction of soils for embankment and sub-grade.

Properties, Storage and Handling of Common Building Materials

IS:269	33 grade for ordinary Portland cement.
IS:383	Coarse and fine aggregates from natural sources for concrete.
IS:432	Specification for mild steel and medium tensile steel bars and
(Part 1&2)	hard drawn steel wires for concrete reinforcement.
IS:455	Portland slag cement.
IS:702	Industrial bitumen.
IS:712	Specification for building limes.
IS:1077	Common burnt clay buidling bricks.
IS:1161	Steel tubes for structural purposes.
IS:1239	Mild steel tubes, tubulars and other wronght steel fillting - MS tubes.
IS:1363	Hexagon head bolts, screws and nuts of productions
(Part 1-3)	grade - C.
IS:1364	Hexagon head bolts, screws and nuts of productions
(Part 1-5)	grade-A & B.
IS:1367 (Part 1-18)	Technical supply condition for threaded fasteners.
IS:1489 (Part-I)	Portland-pozzolana cement. Fly ash based
IS:1542	Sand for Plaster.

IS:1566	Hard drawn steel wire fabric for concrete reinforcement.
IS:1786	High strength deformed steel bars & wires for concrete reinforcement.
IS:2062	Hot Rolled Low, Medium and High Tensile Structural Steel
IS:2116	Sand for masonry mortars.
IS : 2185 (Part 1) (Part 2)	Hollow & solid concrete blocks. Hollow & solid light weight concrete blocks.
IS:2386 (Part I-VIII)	Testing of aggregates for concrete.
IS:3812	Specification for fly ash for use as pozzolona and admixture.
IS:4082	Recommendation on stacking and storage of construction materiel and components at site
IS:8112	43 grade ordinary portland cement.
IS:8500	Structural steel-Microalloyed (Medium and high strength qualities).
IS:12269	53 grade ordinary portland cement.
IS:12894	Specification for fly ash lime bricks.
IS:13757	Burnt clay fly ash building bricks.

Cast in-situ Concrete and Allied Works

IS:280	Mild steel wire for general engineering purpose.
IS:456	Code of practice for plain and reinforcement concrete.
IS:457	Code of practice for general construction of plain and reinforced concrete for dams and other massive structures.
IS:516 IS:1199	Method of test for strength of concrete. Methods of sampling and analysis of concrete.
IS:1791	General requirement for batch type concrete mixers.
IS:1834	Hot applied sealing compound for joints in concrete.
IS:1838	Preformed fillers for expansion joints in concrete pavement and structures.
IS:2438	Specification for roller pan mixers.
IS:2502	Code of practice for bending and fixing of bars for concrete reinforcement.
IS:2505	Concrete vibrators - immersion type.

IS:2506	General requirements for screed board concrete vibrators.
IS:2722	Specification for Portable Swing weigh batchers for concrete (single and double bucket type).
IS:2750	Steel scaffoldings
IS:2751	Recommended practice for welding of mild steel plain and deformed bars for reinforced construction.
IS:3150	Hexagonal wire netting for general purposes.
IS:3366	Specification for pan vibrators.
IS:3370 (Part 1-4)	Code of practice for concrete structures for the storage of liquids.
IS:3558	Code of practice for use of immersion vibrators for consolidating concrete.
IS:4014 (Part-1&2)	Code of practice for steel tubular scaffolding.
IS:4326	Code of practice for earth quake resistant design and construction of buildings.
IS:4656	Form vibrators for concrete.
IS:4925	Concrete batching and mixing plant.
IS:4990	Plywood for concrete shuttering work.
IS:5256	Code of practice for sealing expansion joints in concrete lining on canals.
IS:5525	Recommendations for detailing of reinforcement in reinforced concrete works.
IS:6461	Glossary of terms relating to cement concrete.
IS:6494	Code of practice for water proofing of underground reservoir and swimming pools.
IS:6509	Code of practice for installation of joints in concrete pavements.
IS:7861 (Part -1&2)	Code of practice for extreme weather concreting.
IS:9012	Recommended practice for shotcreting.
IS:9103	Admixtures for concrete.
IS:9417	Recommendations for welding cold worked bars for reinforced concrete construction.
IS:10262	Recommended guidelines for concrete mix design.

IS:11384	Code of practice for composite construction in structural steel and concrete.
IS:12118	Two parts polysulphide based sealants.
IS:12200	Code of practice for provision of water stops at transverse construction joints in masonry and concrete dams.
IS:13311	Non destructive testing of concrete - methods of test.
(Part 1)	Ultrasonic pulse velocity.
(Part 2)	Rebound hammer.
SP-16	Design codes for reinforced concrete to IS:456-1978.
SP-23	Hand book of concrete mixes.
SP-24	Explanatory handbook on Indian standards code for plain and reinforced concrete. (IS : 456)
SP-34	Hand book on concrete reinforcement and detailing.
ACI-318	American Concrete Institute code for structural concrete.

Precast Concrete Works

SP:7 (Part 6/Sec.7)	National Building Code - Structural Design Prefabrication and system building and mixed / composite construction.
IS:10297	Code of practice for design and construction of floors and roofs using precast reinforced/prestressed concrete ribbed or cored slab units.
IS:10505	Code of practice for construction of floors and roofs using pre-cast reinforced concrete waffle units.
IS:15658	Pre-cast concrete block for paving.

Masonry & Allied Works

IS:1905	Code of practice for structural use of unreinforced masonry.
IS: 2185	Part-1 Concrete Masonry Units - Specification Part 1 Hollow and Solid Concrete Blocks Part-3 Specification for concrete masonry units: Part 2 Hollow and solid light weight concrete blocks
IS:2212	Code of practice for brick work.
IS:2250	Code of practice for preparation and use of masonry mortars.
IS:2572	Code of practice for construction of hollow concrete block masonry.
SP:20	Hand book on masonry design and construction.

Sheeting Works

IS:277	Galvanised steel sheets (Plan & corrugated).
IS:513	Cold-rolled low carbon steel sheets & strips.
IS:730	Hook bolts for corrugated sheet roofing.
IS:801	Code of practice for use of cold formed light gauge steel structural members in general building construction.
IS:2527	Code of practice for fixing rain water gutters and down pipe for roof drainage.
IS:7178	Technical supply condition for tapping screw.
IS:8183	Bonded mineral wool.
IS:8869	Washers for corrugated sheet roofing.
IS:12093	Code of practice for laying and fixing of sloped roof covering using plain and corrugated galvanised steel sheets.
IS:12436	Preformed rigid Polyurethane (PUR) and isocyanurate (PIR) foams for thermal insulation.
IS:12866	Plastic translucent sheets made from thermosetting polyester resin (glass fibre reinforced).
IS:14246	Continuously pre-painted galvanised steel sheets and coils.
BS:5950	Code of practice for design of light gauge profiled
(Part-6)	steel sheeting

Fabrication and Erection of Structural Steel Works

IS:800	Code of practice for General Construction of steel.
IS:813	Scheme for symbols for welding.
IS:814	Covered electrodes for manual metal arc welding of carbon & carbon manganese steel.
IS:816	Code of practice for use of metal arc welding for general construction in mild steel.
IS:817	Code of practice for training and testing of metal arc welders.
IS:1024	Welding in bridges and substructured subject to dynamic.
IS:1181	Qualifying tests for Metal Arc welders (engaged in welding structures other than pipes).

	IS:1182	Recommended practice for Radiographic examination of fusion welded butt joints in steel plates
	IS:1608	Mechanical testing of metals - tensile testing
	IS:1852	Rolling and Cutting Tolerances for Hot rolled steel products.
	IS:2016	Specification for Plain washers.
	IS:2595	Code of practice for Radiographic testing
	IS:2629	Hot dip galvanising of iron and steel
	IS:3502	Steel chequred plate.
	IS:3613	Acceptance tests for wire flux combination for submerged arc welding.
	IS:3658	Code of practice for liquid penetrant flaw detection.
	IS:3664	Code of practice for ultra sonic pulse echo testing contact and immersion method
	IS:3757	High strength structural bolts.
	IS:4000	High strength bolts in steel structure - code of practice.
	IS:4353	Sub merged arc welding of mild steel and low alloy steel Recommendation
	IS:4759	Hot dip zinc coating on structural steel and other allied products.
	IS:5334	Code of practice for magnetic particle flaw detection of welds.
	IS:5369	General requirements for plain washers and lock washer
	IS : 6623	High strength structural nuts.
	IS:6649	Hardened and tampered washers for high strength structural bolts & nuts.
	IS:6911	Stainless steel plate, sheet and strip.
	IS:7205	Safety code for erection of structural steel.
	IS:7215	Tolerances for fabrication of structural steel.
	IS:7307	Approved test for welding procedures
	(Part - I)	Fusion welding of steel.
	IS:7310 (Part-I)	Approval test for welders working to approval welding procedure. Fusion welding of steel
	IS:9178 (Part-1to 3)	Criteria for design of steel bins for storage of bulk material.

IS:9595	Recommendations for metal arc welding of carbon & carbon manganese steel.
IS:12843	Tolerances for erection of steel structures.
SP:6 (Part 1 to 7)	ISI Hand book for structural Engineers.

Plastering and Allied Works

IS:1661	Code of practice for application of cement and cement lime plaster finishes.
IS:2402	Code of practice for external rendered finishes.
IS:2547 (Parts 1&2)	Gypsum building plaster.

Acid and Alkali Resistant Lining

IS:158	Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali & heat resisting.
IS:412	Expanded metal steel sheets for general purpose.
IS:4441	Code of practice for use of silica type chemical resistant mortars.
IS:4443	Code of practice for use of resin type chemical resistant mortars.
IS:4456 (Part I & II)	Method of Test for chemical resistant tiles.
IS:4457	Ceramic unglazed vitreous acid resisting tiles.
IS:4832	Specification for chemical resistant mortars.
(Part - 1)	Silicate type
(Part - 2)	Resin type
(Part - 3)	Sulfur type
IS:4860	Acid resistant bricks.
IS:9510	Bitumastic acid resisting grade.

Water Supply, Drainage and Sanitation

IS:458	Precast concrete pipes (with & without reinforcement).
IS:554	Pipe threads where pressure tight joints are made on the threads – dimensions, tolerances and designation.
IS:651	Salt glazed stoneware pipes and fittings.
IS:774	Flushing cisterns for water closets and urinals.

IS:775	Cast iron brackets and supports for wash basins and sinks.
IS:778	Copper alloy gate, globe and check valves for water works purposes.
IS:781	Cast copper alloy screw down bib taps & stop valves for water services.
IS:782	Caulking lead.
IS:783	Code of practice for laying of concrete pipes.
IS:1172	Code of basic requirements of water supply, drainage and sanitation.
IS:1230	Cast iron rain water pipes and fittings.
IS:1239 (Part 1&2)	Mild Steel tubes, tubulars and other wrought steel fittings
IS:1536	Centrifugally cast (Spun) iron pressure pipes for water.
IS:1537	Vertically cast iron pressure pipes for water, gas and sewage.
IS:1538	Cast iron fittings for pressure pipe for water, gas and sewage.
IS:1703	Copper alloy float valve for water supply fitting.
IS:1726	Cast iron manhole covers and frames.
IS:1729	Cast iron / Ductile iron drainage pipes and pipe/fittings for over ground non pressure pipeline socket and spigot series.
IS:1742	Code of practice for building drainage.
IS:2064	Selection, installation and maintenance of sanitary appliances.
IS:2065	Code of practice for water supply in buildings.
IS:2326	Automatic flushing cisterns for urinals.
IS:2548	Plastic seats and covers for water closets.
IS:2556	Vitreous sanitary appliances (vitreous china).
IS:3114	Code of practice for laying of cast iron pipes.
IS:3311	Waste plug and its accessories for sinks and wash basins.
IS:3438	Silvered glass mirrors for general purposes.
IS:3486	Cast iron spigot and socket drain pipes.
IS:3589	steel pipe for water and sewage (168.3 to 2540mm outside diameter)
IS:3989	Centrifugally cast (Spun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.

IS:4111 (Part 1 to 5)	Code of practice for ancillary structure in sewerage system.
IS:4127	Code of practice for laying of glazed stone ware pipes.
IS : 4733	Methods of sampling and testing sewage effluents.
IS:4764	Tolerance limits for sewage effluents discharged into inland surface waters.
IS:1068	Electroplated coating of nickel plus chromium and copper plus nickel plus chromium.
IS:5329	Code of practice for sanitary pipe work above ground for buildings.
IS:5382	Rubber sealing rings for gas mains, water mains and sewers.
IS:5822	Code of practice for laying of electrically welded steel pipes for water supply.
IS:5961	Specification for cast iron grating for drainage purpose.
IS:7740	Code of practice for construction and maintenance of road gullies.
IS:8931	Copper alloy fancy single taps combination tap assembly and stop valves for water services.
IS:9762	Polyethylene floats for float valves.
IS:10592	Industrial emergency showers, eye and face fountains and combination units.
IS:12592	Specification for precast concrete manhole covers and frames.
IS:12701	Rotational moulded polyethylene water storage tanks.
IS:13983	Stainless steel sinks for domestic purposes.
SP:35	Hand book on water supply and drainage with special emphasis on plumbing.
CPH&EEO	Manual on sewage and sewage treatment
Publication	- as updated.

Doors Windows and Allied Works

IS:204	Tower Bolts.
(Part 1)	Ferrous metals
(Part 2)	Non - ferrous metals
IS:208	Door Handles.
IS:281	Mild steel sliding door bolts for use with padlocks.

IS:362	Parliament Hinges.
IS:419	Putty, for use on window frames.
IS:451	Technical supply conditions for wood screws
IS:733	Wrought aluminium and aluminium alloy bars, rods and sections for general engineering purposes.
IS:1003 (Part I)	Timber panelled and glazed shutters (doors shutters).
IS:1003	Timber panelled and glazed shutters
(Part-1)	door shutters.
IS:1038	Steel doors, windows and ventilators.
IS:1081	Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators.
IS:1285	Wrought aluminium and aluminium alloy extruded round tube & hollow section (for general engineering purposes).
IS:1341	Steel butt hinges.
IS:1361	Steel windows for Industrial buildings.
IS:1823	Floor door stoppers.
IS:1868	Anodic coatings on Aluminium and its alloys.
IS:2202	Wooden flush door shutters (solid core type) particle
(Part-2)	board face panels and hard board face panels.
IS:2209	Mortice locks (vertical type)
IS:2553	Safety glass.
(Part-1)	General purposes
IS:2835	Flat transparent sheet glass.
IS:3548	Code of practice for glazing in buildings.
IS:3564	Door closers (Hydraulically regulated)
IS:3614	Specification for fire check doors :
(Part-1)	plate, metal covered and rolling type.
(Part-2)	Resistance test and performance criteria.

IS:4351	Specification for steel door frames.
IS:5187	Flush bolts.
IS:5437	Figured, rolled and wired glass.
IS:6248	Specification for metal rolling shutters and rolling grills.
IS:6315	Specification for floor springs (Hydraulically regulated) for heavy doors.
IS:7196	Hold fast.
IS:7452	Hot rolled steel sections for doors, windows and ventilators.
IS:10019	Mild steel stays and fasteners.
IS:10451	Steel sliding shutters (top hung type)
IS:12823	Prelaminated particle boards.

Roof Water Proofing and Allied Works

IS:3067	code of practice for general design details and preparatory work for damp proofing and water proofing of buildings.
ASTM	Standard specification for high solid content cold
C836-89a	liquid applied elastomeric water proofing membrane for use with separate wearing course.
ASTM	Standard guide for high solid content cold
C898-89	liquid applied elastomeric water proofing membrane for use with separate wearing course.

Floor Finishes and Allied Works

IS:5318	Code of practice for laying of flexible PVC sheet and tile flooring.
IS:8042	White portland cement.
IS:13755	Dust pressed ceramic tiles with water absorption of 3%, E 6% (Group B11a).
IS:13801	Chequered cement concrete tiles.

Painting and Allied Works

IS:162	Ready mixed paint, brushing fire resisting, silicate type for use on wood, colour as required.
IS:428	Distemper, oil, emulsion, colour as required.
IS:1477	Code of practice for painting of terrous metals in buildings.

(Part -1)	Pretreatment.
(Part -2)	Painting.
IS:1650	Specification for colours for building and decorative materials.
IS:2074	Ready mixed paint, air drying, red oxide-zinc chrome, priming.
IS:2338	Code of practice for finishing of wood and wood based materials.
(Part -1)	Operations and Workmanship.
(Part -2)	Schedule.
IS:2395	Code of pratice for painting concrete, masonry and plaster surfaces.
(Part-1)	Operations and Workmanship.
(Part -2)	Schedule.
IS:2524	Code of practice for painting of nonferrous metals in buildings.
(Part -1)	Pretreatment
(Part -2)	Painting.
IS:2932	Enamel, synthetic, exterior, (a) under coating and (b) finishing.
IS:2933	Enamel exterior, (a) under coating, (b) finishing.
IS:4759	Hot dip zinc coatings on structural steel and other allied products.
IS:5410	Specification for cement paint.
IS:15489	Plastic emulsion paint.
IS:6278	Code of practice for white washing and Colour washing.
IS:10403	Glossary of term related to building finish.
IS:12027	Silicone based water repellent
IS:13238	Epoxy based zinc phosphate primer (2 pack)
IS:13239	Epoxy surfacer (2 pack)
IS:13467	Chlorinated rubber for paints
IS:14209	Epoxy enamel, two component glossy.
BS:5493	Code of practice for protective coating of iron and steel structures against corrosion.

Piling and Foundation

IS:1080	Code of practice for design and construction of shallow foundations on soils.
IS:1904	Code of practice for design and construction of foundation in Soils : General Requirements.
IS:2314	Steel sheet piling sections.
IS:2911	Code of practice for design and construction of pile foundations. (Relevant Parts)
IS:2950	Code of practice for designs and construction of Raft foundation.
(Part-1)	Design
IS:2974 (Part-1 to 5)	Code of practice for design and construction of machine foundation.
IS:4091	Code of practice for design and construction foundations for transmission line towers and poles.
IS:6403	Code of practice for determination of Bearing capacity of Shallow foundations.
IS:8009	Code of practice for calculation of settlement of foundation.
(Part -1)	Shallow foundations.
(Part -2)	Deep foundations.
IS:12070	Code of practice for design and construction of shallow foundations on rocks.
ISO 10816	Criteria for assessing mechanical vibrations of machines.
ISO 1940	Criteria for assessing the st of balance of rotating rigid bodies.
DIN : EN 13906-1	Helical compression spring made of round wire and rod : calculation and design of compression .
DIN:2096	Helical compression spring out of round wire and rod : Quality requirements for hot formed compression spring.
DIN:4024	Flexible supporting structures for machine with rotating machines.

Roads

IRC:5 (Section-1)	Standard specifications and Code of practice for road bridges, General Features of Design.
IRC:14	Recommended practice for 2cm thick bitumen and tar carpets.

	IRC:15	Standard specifications and code of practice for construction of concrete roads.
	IRC:16	Specification for priming of base course with bituminous primers.
	IRC:19	Standard specifications and Code of practice for water bound macadam.
	IRC:21 (Section-III)	Standard specifications and Code of practice for road bridges. Cement concrete (plain and reinforced).
	IRC:34	Recommendations for road construction in water logged areas.
	IRC:36	Recommended practice for the construction of earth embankments for road works.
	IRC:37	Guidelines for the Design of flexible pavements.
	IRC:56	Recommended practice for treatment of embankment slopes for erosion control.
	IRC:58	Guidelines for the design of rigid pavements for highways.
	IRC:73	Geometric Design standards for rural (non-urban) highways.
	IRC : 86	Geometric Design standards for urban roads in plains.
	IRC:SP:13	Guidelines for the design of small bridges & culverts.
	IRC - Publication	Ministry of Surface Transport (Road wing), specifications for road and bridge works.
	IS:73	Paving bitumen.
	Loading	
	IS:875 (Relevant parts)	Code of practice for design loads (other than earthquake) for buildings and structures.
	IS:1893	Criteria for earthquake resistant design of structures.
	IS:4091	Code of practice for design and construction of foundation for transmission line towers and poles.
	IRC:6 (Section-II)	Standard specifications & Code of practice for road bridges. loads and stresses
	Safety	
	IS:1641	Code of practice for fire safety of buildings - General principles of fire grading and classification.
	IS:1642	Code of practice for fire safety of buildings - Details of construction.
	IS:3696	Safety code for scaffolds and ladders.

(Part-1&2)

IS:3764	Excavation work - code of safety.
IS:4081	Safety code for blasting and related drilling operations.
IS:4130	Demolition of buildings - code of safety.
IS:5121	Safety code for piling and other deep foundations.
IS:5916	Safety code for construction involving use of hot bituminous materials.
IS:7205	Safety code for erection of structural steel work.
IS:7293	Safety code for working with construction machinery.
IS:7969	Safety code for handling and storage of building materials.
Indian Explosives Act 1940)	(As updated)

Architectural Design of Buildings

SP:7	National Building Code of India
SP:41	Hand book on functional requirements of buildings (other than industrial buildings)
ECBC	Energy Conservation Building Code
GRIHA	Green Rating For Integrated Habitat Assessment.

Chimney

IS:4998	Criteria for design of reinforced chimneys
IS:6533	Code of practice for design and construction of steel chimneys
ICAO	International Civil Aviation Organisation (ICAO)
DGCA	Instruction of Director General of Civil Aviation , India
ACI:307	Specification for the design and construction of reinforced concrete chimneys
BS:4076	Specification for steel chimneys
CICIND	Model Code for concrete chimneys Model code for steel chimneys
ASCE Code	Design and construction of steel chimney liners prepared by Task committee on steel chimney liners. Fossil power committee, Power division published by ASCE - 1975.
IS:1554	PVC insulated (heavy duty) electric cables
IS:2606	Alloy lead anodes for chromium plating

IS:3043	Code of Practice for Earthing
IS:9537	Conduits for electrical installations. The Indian Electricity Rules The Indian Electricity Act The Indian Electricity (Supply) Act The Indian Factories Act
IS:2309	Practice for protection of buildings and allied structures against lightning

Miscellaneous

IS:802 (Relevant parts)	Code of practice for use of structural steel in overhead trans-mission line towers.
IS:803	Code of practice for design, fabrication and erection of vertical mild steel cylindrically welded in storage tanks.
IS:10430	Criteria for design of lined canals and guidance for selection of type of lining.
IS:11592	Code of practice for selection and design of belt conveyors.
IS:12867	PVC handrails covers.
IS 11504	Criteria for structural design of reinforced concrete natural draught cooling towers
BS:4485 (IV)	British Standard : Code of design for water cooling towers
CIRIA Publication	Design and construction of buried thin-wall pipes.
IS 4671	Expanded polystyrene for thermal insulation purposes.

ANNEXURE (b)

CONSTRUCTION METHODOLOGY

Construction and erection activities shall be fully mechanised from the start of the work.

All excavation and backfilling work shall be done using excavators, loaders, dumpers, dozers, poclains, excavator mounted rock breakers, rollers, sprinklers, water tankers, etc. Manual excavation can be done only on isolated places with specific approval of engineer.

For controlled rock blasting specialized agency, equipped with sensors to assess the impact of the blast on the adjoining existing structures, shall be employed.

Dewatering shall be done using the combination of electrical and standby diesel pumps.

Pile installation equipment suitable for flushing with air lift technique shall be used for construction of bored piles.

For concreting, weigh batching plants, transit mixers, concrete pumps, hoists, etc. shall be used.

All fabrication and erection activities of structural steel shall be carried out using automatic submerged arc welding machines, cutting machines, gantry cranes, crawler mounted heavy cranes and other equipment like heavy plate bending machines, shearing machines, lathe, milling machines, etc. Use of derricks shall not be permitted. Special enclosures, for blast cleaning of steel structure surface preparation, shall be used.

All handling of materials shall be with cranes. Heavy trailers shall be used for transportation.

Mechanized modular units of scaffolding and shuttering shall be used.

Grouting shall be carried out using hydaulically controlled grouting equipment.

Roadwork shall be done using pavers, rollers and premix plant.

All finishing items shall be installed using appropriate modern mechanical tools. Manual punching etc. shall not be permitted.

Heavy duty hoists for lifting of construction materials shall be deployed. Compressors for cleaning of foundations and other surfaces shall be used.

Field laboratory shall be provided with all modern equipment for survey, testing of soil, aggregates, concrete, welding, etc. For testing of steel works, ultrasonic testing machines, radiographic testing machines, dye penetration test equipment, destruction testing equipment, etc. shall be deployed.

All persons working at site shall be provided with necessary safety equipment and all safety aspects shall be duly considered for each construction/ erection activity. Moreover, only the persons who are trained in the respective trade shall be employed for executing that particular work.

ANNEXURE- (d)

CRITERIA FOR WIND RESISTANT DESIGN OF STRUCTURES AND EQUIPMENT

All structures shall be designed for wind forces in accordance with IS 875 (Part-3) and as specified in this document. See Annexure – B for site specific information.

Along wind forces shall generally be computed by the Peak (i.e. 3 second gust) Wind Speed method as defined in the standard.

Along wind forces on slender and wind sensitive structures and structural elements shall also be computed, for dynamic effects, using the Gust Factor or Gust Effectiveness Factor Method as defined in the standard. The structures shall be designed for the higher of the forces obtained from Gust Factor method and the Peak Wind Speed method.

Analysis for dynamic effects of wind must be undertaken for any structure which has a height to minimum lateral dimension ratio greater than “5” and/or if the fundamental frequency of the structure is less than 1 Hz.

Susceptibility of structures to across-wind forces, galloping, flutter, ovalling etc. should be examined and designed/detailed accordingly following the recommendations of IS 875(Part-3) and other relevant Indian standards.

It should be estimated if size and relative position of other structures are likely to enhance the wind loading on the structure under consideration. Enhancement factor, if necessary, shall suitably be estimated and applied to the wind loading to account for the interference effects.

Damping in Structures

The damping factor (as a percentage of critical damping) to be adopted shall not be more than as indicated below for:

a) Welded steel structures : 1.0%

b) Bolted steel structures : 2.0%

c) Reinforced concrete structures : 1.6%

d) Steel stacks : As per IS 6533 & CICIND Model Code whichever is more critical.

SITE SPECIFIC DESIGN PARAMETERS

The various design parameters, as defined in IS 875 (Part-3), to be adopted for the project site shall be as follows:

a) The basic wind speed “V_b” at ten metre above the mean ground level: 39 metre/second

b) The risk coefficient “K_1” : 1.06

c) Category of terrain : Category-2

Annexure-(E)

CRITERIA FOR EARTHQUAKE RESISTANT DESIGN OF STRUCTURES AND EQUIPMENT

Refer Annexure- 2 for detail

All structures and equipment shall be designed for seismic forces adopting the site specific seismic information provided in this document and using the other provisions in accordance with IS:1893 (Part 1):2002 and IS:1893 (Part 4):2005. Pending finalization of Parts 2, 3 and 5 of IS:1893, provisions of part 1 shall be read along with the relevant clauses of IS:1893:1984, for structures other than the buildings and industrial structures including stack-like structures.

A site specific seismic study has been conducted for the project site. The peak ground horizontal acceleration for the project site, the site specific acceleration spectral coefficients (in units of gravity acceleration 'g') in the horizontal direction for the various damping values and the multiplying factor (to be used over the spectral coefficients) for evaluating the design acceleration spectra are as given at Annexure-I.

Vertical acceleration spectral values shall be taken as 2/3rd of the corresponding horizontal values.

The site specific design acceleration spectra shall be used in place of the response acceleration spectra, given at figure-2 in IS:1893 (Part 1) and Annex B of IS:1893 (Part 4). The site specific acceleration spectra along with multiplying factors specified in Annexure-I includes the effect of the seismic environment of the site, the importance factor related to the structures and the response reduction factor. Hence, the design spectra do not require any further consideration of the zone factor (Z), the importance factor (I) and response reduction factor (R) as used in the IS:1893 (Part 1 and Part 4).

Damping in Structures

The damping factor (as a percentage of critical damping) to be adopted shall not be more than as indicated below for:

Steel structures	2 %
Reinforced Concrete structures	5 %
Reinforced Concrete Stacks	3 %
Steel stacks	2 %

Method of Analysis

Since most structures in a power plant are irregular in shape and have irregular distribution of mass and stiffness, dynamic analysis for obtaining the design seismic forces shall be carried out using the response spectrum method. The number of vibration modes used in the analysis should be such that the sum total of modal masses of all modes considered is at least 90 percent of the total seismic mass and shall also meet requirements of IS:1893 (Part 1). Modal combination of the peak response quantities shall be performed as per Complete Quadratic Combination (CQC) method or by an acceptable alternative as per IS:1893 (Part 1).

In general, seismic analysis shall be performed for the three orthogonal (two principal horizontal and one vertical) components of earthquake motion. The seismic response from the three components shall be combined as specified in IS:1893 (Part 1).

For buildings, if the design base shear (VB) obtained from modal combination is less than the base shear ($\overline{V}B$) computed using the approximate fundamental period (Ta) given in IS:1893:Part 1 and using site specific acceleration spectra with appropriate multiplying factor, the response quantities (e.g. member forces, displacements, storey forces, storey shears and base reactions) shall be enhanced in the ratio of $\overline{V}B$/ VB. However, no reduction is permitted if $\overline{V}B$ is less than VB.

For regular buildings less than 12m in height, design seismic base shear and its distribution to different floor levels along the height of the building may be carried out as specified under clause 7.5, 7.6 & 7.7 of IS:1893 (Part 1) and using site specific design acceleration spectra. The design horizontal acceleration spectrum value (Ah) shall be computed for the fundamental natural period as per clause 7.6 of IS:1893 (Part 1) using site specific spectral acceleration coefficients with appropriate multiplying factor given in Annexure-I. Further, the spectral acceleration coefficient shall get restricted to the peak spectral value if the fundamental natural period of the building falls to the left of the peak in the spectral acceleration curve.

Design/Detailing for Ductility for Structures

The site specific design acceleration spectra is a reduced spectra and has an in-built allowance for ductility. Structures shall be engineered and detailed in accordance with relevant Indian/International standards to achieve ductility.

SITE SPECIFIC SEISMIC PARAMETERS FOR DESIGN OF STRUCTURES AND EQUIPMENT

The site specific seismic parameters for the project site shall be furnished later.

Annexure-(f)

QA REQUIREMENT

All Civil, Structural and Architectural construction work at the project shall be executed strictly in accordance with the Quality Assurance guidelines specified in separate part of this Specification.

Annexure-(g)

RAINFALL DATA

For Rain fall data refer Meteorological Data indicated in project information Sub-Section-IB in Part-A.

ANNEXURE - H

Specification For High Performance Moisture Compatible Corrosion Resistant Coating System

a) Providing & applying **High Performance Moisture Compatible Corrosion Resistant Coating System** manufactured as per technical specifications of Central Electrochemical Research Institute, Karaikudi, (C.S.I.R. affiliate Institute), Tamil Nadu, Pin - 630 006.

b) The coating system shall be water compatible, compatible for applying in wet conditions also and shall be tolerant to under-prepared surfaces and existing residual tar / paint. The system shall also be quick curing so as to be suitable for application during shut downs.

The coating material shall be stored in the manner as per recommendations of the manufacturer until ready for use. The coating material shall be used within the manufacturer's written recommended shelf life.

Annexure-(i)

List of tender drawings attached with this specification include

Sl No.	Title	Drg No.
1)	General Layout Plan	9585-999-POC-F-001-Rev 4
2)	Site Levelling Works	9585-001-POC-A-001-Rev D
3)	Topographical Survey Detail	9585-001-PVC-F-002-RevA
4)	Owner's Construction Office	9585-001-POC-A-002-Rev-A
	Safety Park Architectural Details and specifications	9585-001-POC-A-005- REV-A
	Typical Layout of Make up water pipeline	9585-001-POC-A-006-Rev-A
	Typical Details of Make up water pipeline Crossings	9585-001-POC-A-007-Rev-B

Annexure-(J)

ELECTRICAL RESISTIVITY DATA

Preliminary Geotechnical Investigation Work for Proposed Main Plant and Ash Pond at PTPS Jharkhand

TABLE NO - 15

Depth (m)	ERT 01	ERT 02	ERT 03	ERT 04	ERT 05	ERT 06	ERT 07	ERT 08	ERT 09	ERT 10
0.5	18.13	21.53	147.11	223.05	213.65	303.24	1862.96	131.85	180.76	17.12
1	20.48	25.43	116.33	205.50	173.20	235.47	677.01	131.95	164.46	20.31
2	11.08	25.79	99.22	190.86	142.64	205.47	376.47	122.98	132.17	16.83
3	10.10	22.58	78.15	159.75	129.53	262.59	386.96	113.74	128.83	18.29
4	10.59	17.36	69.24	138.08	117.84	253.84	317.45	106.04	140.78	19.98
5	11.66	16.81	56.74	122.59	104.12	274.81	238.13	87.24	159.04	21.56
6	12.14	18.12	51.36	139.91	110.59	311.52	126.41	81.75	174.96	23.10
7	12.69	9.57	47.95	146.15	104.56	308.88	227.05	58.98	169.46	24.08
8	11.95	10.09	44.25	115.79	100.72	310.53	223.05	53.91	152.19	25.49
9	13.06	9.87	43.31	132.89	87.74	335.44	243.87	42.69	148.58	29.89
10	13.05	10.39	43.28	129.15	84.56	327.96	233.41	35.84	132.45	28.24

TABLE NO - 16

Depth (m)	ERT 11	ERT 12	ERT 13	ERT 14	ERT 15	ERT 16	ERT 17	ERT 18	ERT 19
0.5	35.07	235.93	321.39	106.62	43.73	234.12	314.31	302.85	304.34
1	39.53	171.94	295.01	97.39	35.78	231.72	224.94	274.24	282.05
2	43.79	129.90	262.44	42.49	34.77	226.58	154.84	241.55	266.75
3	50.78	123.55	256.21	32.36	31.71	194.83	109.17	237.81	235.43
4	57.01	119.66	216.42	27.25	30.79	174.13	85.26	153.60	227.80
5	60.59	138.55	218.34	30.77	24.64	142.84	85.54	128.28	214.96
6	63.06	154.84	185.62	32.99	21.53	111.79	80.77	127.23	191.01
7	61.19	152.40	154.04	36.14	20.10	105.05	78.66	143.73	179.71
8	64.74	139.94	114.46	37.70	18.35	100.60	69.00	128.60	159.00
9	65.05	123.46	62.44	38.29	20.11	88.36	61.39	124.21	137.50
10	66.86	118.68	51.05	41.07	19.76	74.24	50.67	108.91	140.00

ARKITECHNO

ARKI TECHNO
CONSULTANTS (INDIA) PVT LTD

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ELECTRICAL RESISTIVITY TEST:-

The Electrical Resistivity Tests have been conducted at 19 proposed sites as per list below (***Table-1***) along two perpendicular lines in both North-South and East-West direction at each site using Werner's four electrode methods specified in IS:1892, Appendix-B2. On each line 11 readings have been taken by changing the spacing of the electrodes from 0.5m up to a distance of 10m.

***Table-1*: ERT SITES**

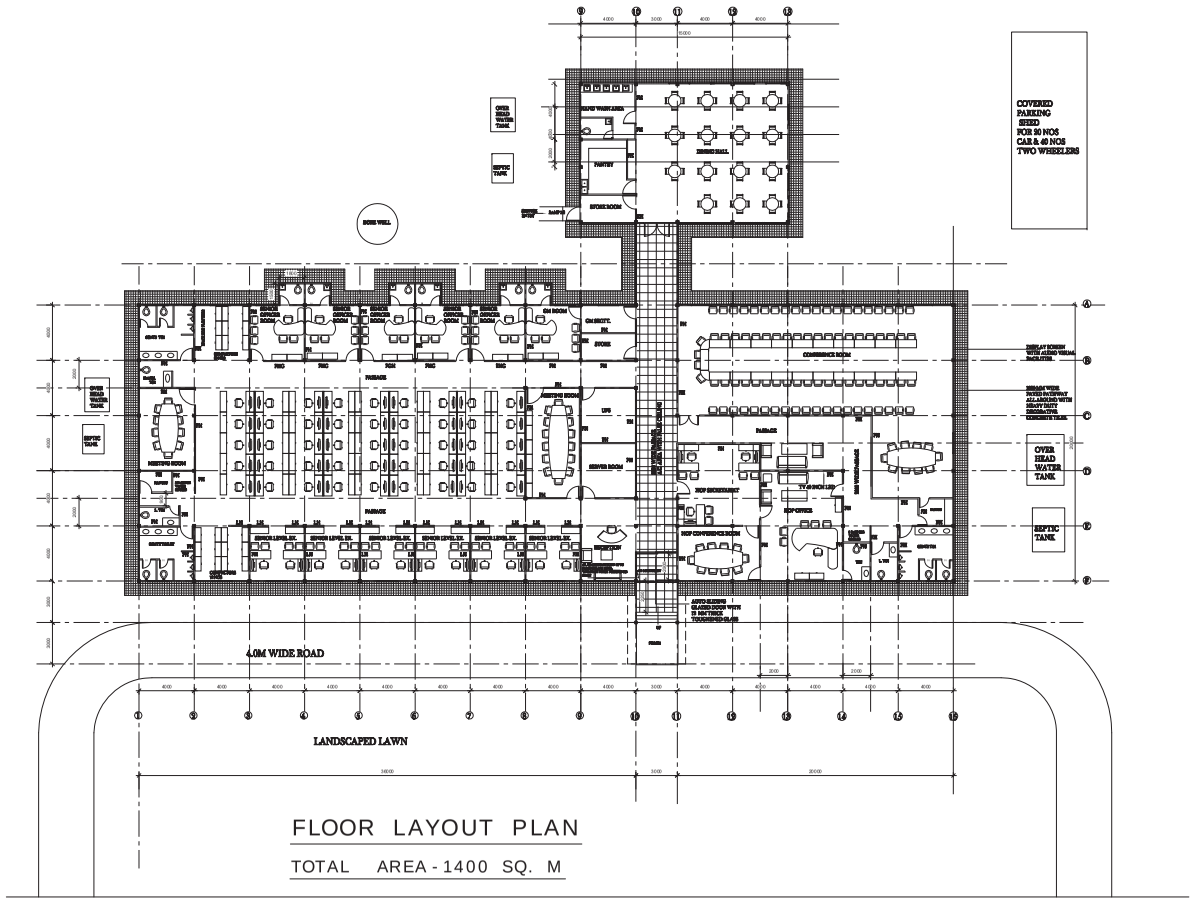
Sl. No.	Site Id	Coordinates	
1	ERT-01	N2615944	E325421
2	ERT-02	N2616080	E325302
3	ERT-03	N2616088	E325465
4	ERT-04	N2616033	E325579
5	ERT-05	N2616220	E325576
6	ERT-06	N2616165	E325660
7	ERT-07	N2616165	E325695
8	ERT-08	N2616165	E325695
9	ERT-09	N2616166	E325716
10	ERT-10	N2616450	E325790
11	ERT-11	N2616014	E-325991
12	ERT-12	N2616338	E-326131
13	ERT-13	N2615650	E-325208
14	ERT-14	N2615461	E-325165
15	ERT-15	N2615358	E-324950
16	ERT-16	N2615171	E 325514
17	ERT-17	N2614851	E325623
18	ERT-18	N2617335	E325758
19	ERT-19	N2615341	E326174

TABLE NO - 15

Depth (m)	ERT 01	ERT 02	ERT 03	ERT 04	ERT 05	ERT 06	ERT 07	ERT 08	ERT 09	ERT 10
0.5	18.13	21.53	147.11	223.05	213.65	303.24	1862.96	131.85	180.76	17.12
1	20.48	25.43	116.33	205.50	173.20	235.47	677.01	131.95	164.46	20.31
2	11.08	25.79	99.22	190.86	142.64	205.47	376.47	122.98	132.17	16.83
3	10.10	22.58	78.15	159.75	129.53	262.59	386.96	113.71	128.83	18.29
4	10.59	17.36	69.24	138.08	117.84	253.84	317.45	106.04	140.78	19.98
5	11.66	16.81	56.74	122.59	104.12	274.81	238.13	87.24	159.04	21.56
6	12.14	18.12	51.36	139.91	110.59	311.52	126.41	81.75	174.96	23.10
7	12.69	9.57	47.95	146.15	104.56	308.88	227.06	58.98	169.46	24.08
8	11.95	10.09	44.25	115.79	100.72	310.53	223.05	53.91	152.19	25.49
9	13.06	9.87	43.31	132.89	87.74	335.44	243.87	42.69	148.58	29.89
10	13.05	10.39	43.28	129.15	84.56	327.96	233.41	35.84	132.45	28.24

TABLE NO - 16

Depth (m)	ERT 11	ERT 12	ERT 13	ERT 14	ERT 15	ERT 16	ERT 17	ERT 18	ERT 19
0.5	35.07	235.93	321.39	106.62	43.73	234.12	314.31	302.85	304.34
1	39.53	171.94	295.01	97.39	35.78	231.72	224.94	274.24	282.05
2	43.79	129.90	262.44	42.49	34.77	226.58	154.84	241.55	266.75
3	50.78	123.55	256.21	32.36	31.71	194.83	109.17	237.81	235.43
4	57.01	119.66	216.42	27.25	30.79	174.13	85.26	153.60	227.80
5	60.59	138.55	218.34	30.77	24.64	142.84	85.54	128.28	214.96
6	63.06	154.84	185.62	32.99	21.53	111.79	80.77	127.23	191.01
7	61.19	152.40	154.04	36.14	20.10	105.05	78.66	143.73	179.71
8	64.74	139.94	114.46	37.70	18.35	100.60	69.00	128.60	159.00
9	65.05	123.46	62.44	38.29	20.11	88.36	61.29	124.21	137.50
10	66.86	118.68	51.05	41.07	19.76	74.24	50.67	108.91	140.00



FLOOR LAYOUT PLAN

TOTAL AREA - 1400 SQ. M

LEGEND:

1. FH- FULL HEIGHT CABIN WITH MODULAR PARTITION FOR AGM / GM (06 NOS)
2.FHG- FULL HEIGHT CABIN WITH MODULAR PARTITION & TOUGHENED6 MM THICK ETCHED GLASS ABOVE 1500 HIGH OPAQUE PARTITION
3. LH - LOW HEIGHT (1350MM) CABINS WITH MODULAR PARTITION FOR SR. MANAGER / DGM (12 NOS)
4. WS - WORK STATION S FOR E) TO E5 (45 NOS)
5. SC- STORAGE CABINETS LOW HEIGHT (1200 MM)
6. WSP- WORK STATION PARTITION 1350 MM HIGH
7. HOP - HEAD OF PROJECT FULL HEIGHT CABIN 1 NO.
8. HOP SECRETARIAT FULL HEIGHT CABIN 3 NOS

OWNER'S CONSTRUCTION OFFICE

THIS BUILDING SHALL BE A SINGLE STOREYED BUILDING WITH FLOOR AREA OF 1400 SQ. M OF PRE-ENGINEERED BUILDING WITH STEEL FRAME CONSTRUCTION, WITH MINIMUM FLOOR TO ROOF HEIGHT 4.25M AND INSULATED SANDWICH CLADDING FOR WALLS AND SANDWICHED METAL SHEET ROOFING. THE DESIGN OF THE BUILDING SHALL BE SUCH SO AS TO HAVE FASTER CONSTRUCTION OF BUILDING AND SO AS TO PROVIDE A READY TO USE BUILDING, COMPLETE AND FINISHED IN ALL RESPECTS TO THE OWNER. THIS BUILDING SHALL PROVIDE OFFICES SENIOR OFFICERS, CONFERENCE ROOMS LARGE OFFICE HALLS WITH LAYOUT AND OCCUPANCY AS SHOWN IN THE DRAWING.

SCOPE OF WORK.

1. .DESIGNING, MANUFACTURING, SUPPLY, PACKING, LOADING, TRANSPORTATION, UNLOADING, INSTALLING AND COMMISSIONING THE PRE-FABRICATED PORTABLE, DETACHABLE, DOUBLE LAYER INSULATED PORTA CABINS,SANDWICHED METAL SHEET ROOFING, EAVES GUTTER & RAIN WATER DOWN COMER AS PER LAYOUT SHOWN INCLUDING FOUNDATIONS, SUBSTRUCTURES AND SUPER STRUCTURES AND ALL FINISHING, COMPLETE IN ALL RESPECTS.

2. MAIN MS FRAME WITH MS STANDARD BRACING WITH VERTICAL AND HORIZONTAL GRIDS WITH DIPPED ANTI-CORROSIVE COATINGS BE GROUTED TO R.C.C FLOOR / PLATFORM. THE PLINTH SHALL BE 500 MM HIGH WITH PERIPHERAL R.C.C WALL AND 100 MM THICK P.C.C

3.SANDWICHED METAL SHEET FOR ROOFING CONSISTING OF TOP SHEET AS TROUGHED PERMANENTLY COLOUR COATED SHEET & BOTTOM SHEET AS PLAIN PERMANENTLY COLOUR COATED FOR COVERING OF EXPOSED METAL/ CONCRETE / BRICK SURFACES WITH 50 MM THICK INSULATION SANDWICHED BETWEEN THE TWO SHEETS, EACH SHEET SHALL BE OF STEEL WITH ZINC COATED TO CLASS 275 WITH MINIMUM BARE METAL THICKNESS (I.E. EXCLUDING THE THICKNESS OF COATING AND PAINTING) OF 0.6MM OF GRADE G250 AS PER AS1397 / GRADE S8255 AS PER ASTM A653M / GRADE S250GD AS PER EN 10326 OR OF STEEL WITH ALUMINUM-ZINC ALLOY COATED TO CLASS AZ150 WITH MINIMUM BARE METAL THICKNESS (I.E. EXCLUDING THE THICKNESS OF COATING AND PAINTING) OF 0.5MM OF GRADE G350 AS PER AS1397 / GRADE SS340 CLASS 4 AS PER ASTM A792M / GRADE S350GD AS PER EN 10326 OR OF STEEL WITH ALUMINIUM-ZINC ALLOY COATED TO CLASS AZ150 WITH MINIMUM BARE METAL THICKNESS (I.E. EXCLUDING THE THICKNESS OF COATING AND PAINTING) OF 0.4MM OF GRADE G550 AS PER AS1397 / GRADE S550 AS PER ASTM A792M / GRADE S550GD AS PER EN 10326

4. WALL CLADDING SHALL CONSIST OF AN OUTER WALL OF HALF HOUR FIRE RATED,10 MM THICK SILICA FIBER BOARD CLADDING(100 % ASBESTOS AND TERMITE FREE, WITH DENSITY > 1200 KG/ SQ. M) FIXED OVER STEEL GRID BY SELF THREADED STUDS / PASTED WITH UNDER WATER ITALIAN EPOXY AND INTERNAL WALL SHALL BE 12.5MM THICK GYPSUM BOARD CONFIRMING TO IS:2095 PART-I FINISHED WITH ACRYLIC EMULSION PAINT OF DULUX / ASIAN/ NEROLAC OR EQUIVALENT THE EDGE OF THE BOARD SHALL BE PROPERLY SEALED WITH PU HIGH EPOXY AND STANDARD CHANNELS WHEREVER REQUIRED. INSULATION OF GLASS WOOL (DENSITY 32 KG/CU.M) UPTO 50 MM NOMINAL THICKNESS SHALL BE PROVIDED IN BETWEEN OUTER AND INTERNAL CLADDING.SANDWICHED WALL CLADDING SHALL BE FINISHED ON OUTER SIDE WITH 4MM THICK AL. COMPOSITE PANEL SHEET.

5 .DOOR & WINDOWS SHALL BE PROVIDED AS PER THE LAYOUT SHOWN WITH MINIMUM WINDOW AREA OF 20 % OF THE CARPET AREA. POWDER COATED AL. FARMES WITH MINIMUM WALL THICKNESS OF 2 MM FOR DOOR WINDOWS & VENTILATORS WITH 24 MM THICK HERMETICALLY SEALED DOUBLE GLAZING WITH TOUGHENED GLASS FOR WINDOWS AND 8 MM THICK TOUGHENED GLASS FOR GLAZED DOORS. MAIN ENTRANCE DOOR SHALL BE GLAZED AUTO SLIDING DOOR. FOR TOILETS & PANTRIES DECORATIVE TYPE LAMINATED FLUSH DOOR SHUTTER SHALL BE PROVIDED ALL THE NECESSARY ACCESSORIES AND HARDWARE SHALL BE PROVIDED. VERTICAL VENETIAN BLINDS IN PREMIUM FABRIC QUALITY SHALL BE PROVIDED FOR ALL THE WINDOWS.

6. FALSE CEILING IN PERFORATED ALUMINIUM TILES / PLANKS OF ARMSTRONG/ HUNTER DOUGLAS OR EQUIVALENT WITH ACOUSTICAL FLEECE ABOVE SHALL BE PROVIDED IN THE ENTIRE BUILDING.

7 MIRROR POLISHED VITRIFIED TILE FLOORING (SIZE 800MM X 800 MM) OF KAJARIA / JHONSON MAKE SHALL BE PROVIDED FOR OFFICE AREAS. FOR CONFERENCE ROOM LAMINATED WOODEN FLOORING SHALL BE PROVIDED FOR SENIOR OFFICER ROOM PREMIUM QUALITY CARPET FLOORING SHALL BE PROVIDED. DUST PRESSED CERAMIC TILES FLOORING SHALL BE PROVIDE FOR TOILETS & PANTRIES / KITCHEN WITH DESIGNER DECORATIVE CERAMIC TILE ON WALL CLADDING UPTO FALSE CEILING SHALL BE PROVIDED.

8. ALL THE PARTITIONS AS PER THE LAYOUT - FULL HEIGHT / LOW HEIGHT BASED ON MODULAR PARTITION DESIGN OF GODREJ / JASANI OR EQUIVALENT SHALL BE PROVIDED

9. ALL THE FURNITURE AS SHOWN INCLUDING MODULAR WORK STATIONS, EXECUTIVE CHAIRS&TABLES, CONFERENCE TABLES, STORAGE / COMPACTORS, VISITOR CHAIRS, SOFAS, RECEPTION TABLE, DINING TABLE & CHAIRS ETC OF GODREJ / FEATHERLITE / JASANI OR EQUIVALENT SHALL BE PROVIDED.

10. ALL THE TOILETS IN WORKING CONDITIONS INCLUDING MALE & FEMALE TOILETS, HANDICAPPED TOILET, ATTACHED TOILETS, WASH ROOMS, PANTRY / KITCHEN COMPLETE IN ALL RESPECTS WITH SENSOR BASED WASH BASIN SET IN GRANITE COUNTERS, SENSOR BASED URINALS, DUAL FLUSH WALL HUNG W.C WITH SENSOR BASED TAPS OF JAGUAR OR EQUIVALENT. ALL THE NECESSARY ACCESSORIES OF PREMIUM QUALITY SHALL BE PROVIDED.

11. INTELLIGENT AND ENERGY EFFICIENT LED LIGHTING WITH MINIMUM LUX LEVEL AS MENTIONED BELOW WITH RECESSED OPTIC LUMINARES / LED DOWN LIGHTERS/ PENDANT LIGHT/ ASCENT LIGHT OF PHILIPS/ WIPRO/ CROMPTON GREAVES/ HAVELLS OR EQUIVALENT, COMPLETE IN ALL RESPECTS WITH ASSOCIATED CABLING, FIXTURES LIKE FANS , SWITCHES, MCB, ENERGY MANAGEMENT SYSTEM LIKE DIMMERS / SENSORS ETC.
a)OFFICES, CONFERENCE ROOM ETC.-300 LUX , DECORATIVE MIRROR OPTIC TYPE LED LUMINARIES OR LED DOWNLIGHTER.
b)CAR PARKING.-50 LUX , INDUSTRIAL TYPE LED LUMINARIES .
c) CANTEEN: - 150 LUX , INDUSTRIAL TYPE LED LUMINARIES .
d) CORRIDOR / PASSSAGE: 50 LUX , LED LUMINARIES
e) BUILDING PERIPHERY LIGHTING :- 50 LUX , LED LUMINARIES / LED STREET LIGHT FIXTURES.
f)OTHER AREAS NOT COVERED ABOVE :- LIGHTING PRINCIPLES SHALL BE BASED AS MENTIONED ABOVE

12. THE BUILDING SHALL BE COMPLETELY AIR-CONDITIONED BUILDING. SPLIT A.C SHALL BE PROVIDED FOR OFFICE CABINS AND CASSETTE TYPE AIR- CONDITIONERS FOR CONFERENCE ROOM, HOP OFFICE AND WORK STATION AREA. CAPACITY OF THE A.C SYSTEM SHALL BE @ 1 TON PER 10 SQ.M CARPET AREA AND A.C EQUIPMENT SHALL CONFORM TO 4 STAR RATING OF BEE AND SHALL BE OF LG/ VOLTAS/ BLUE STAR/ HITACHI OR EQUIVALENT MAKE.

13. FIRE DETECTION AND FIRE FIGHTING SYSTEM COMPLETE IN ALL RESPECT.

14. COMPLETE CONCEALED CABLING NETWORK FOR IT - INTEGRATED OFFICE WITH INTRANET CONNECTIONS AND THE ASSOCIATED COMMUNICATION NETWORKS.

15. R.O PLANT FOR PROVIDING DRINKING WATER, WATER COOLERS AS SHOWN IN THE LAYOUT & TWO NUMBERS REFRIGERATORS OF 600 LITRES CAPACITY. (OF MAKE SAMSUNG / LG / PANASONIC / GODREJ OR EQUIVALENT)

16. AUDIO- VISUAL EQUIPMENTS LIKE OVERHEAD PROJECTORS, DISPLAY BOARDS & VIDEO CONFERENCING IN THE CONFERENCE ROOM. ONE LED TV 40 INCH MINIMUM OF SONY/ SAMSUNG MAKE SHALL BE PROVIDED IN HOP OFFICE

17. 1 NO. BORE WELL WITH SUBMERSIBLE PUMP AND ASSOCIATED PIPES AND FITTINGS FOR FILLING OVERHEAD WATER TANK, 3 NOS. PVC OVERHEAD WATER TANK , AND 3 NOS. SEPTIC TANK SHALL BE PROVIDED.

18. COVERED PARKING SHED IN MULTI WALL POLYCARBONATE SHEET & STEEL STRUCTURE FOR 30 NUMBERS CAR &50 NUMBERS TWO WHEELER SHALL BE PROVIDED.

EXCLUSIONS

1. PANTRY / KITCHEN EQUIPMENTS

2. COMPUTERS, UPS AND TELEPHONE SETS

NOTES:

1. ALL THE FINISHING MATERIALS SAMPLES, COLOUR / SHADE SHALL BE GOT APPROVED FROM ENGINEER-IN-CHARGE BEFORE EXECUTION.

2. WHEREVER MULTIPLE CHOICE FOR MATERIALS MAKE HAS BEEN GIVEN, FINAL DECSISON OF SELECTION OF MATERIAL MAKE RESTS WITH THE ENGINEER-IN CHARGE.

3. THIS DRAWING IS A PART OF MAIN PACKAGE AND SPECIFICATIONS DETAILED IN THE MAIN PACKAGE SHALL BE APPLICABLE

4. THE SPACE MARKED FOR SEPTIC TANK , BORE WELL AND PARKING FACILITIES ARE INDICATIVE. FINAL LOCATIONS SHALL BE AS PER SITE CONDITIONS

FOR TENDER PURPOSE ONLY

REV.NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M(L/O)	M(WS)	E	C	C&I	APPD	DATE
A	RELEASED FOR TENDER PURPOSE										01.08.16
					CLEARED BY						

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NTPC Limited
(A GOVERNMENT OF INDIA ENTERPRISE)
ENGINEERING DIVISION

PROJECT: PATRATU SUPER THERMAL POWER PROJECT (3 X 800 MW)

TITLE: EPC PACKAGE
CONSTRUCTION OFFICE
ARCH. DETAILS

SIZE	SCALE	DRG. NO.	REV. NO.
		9585-001-POC-002	A

CAD FILE NAME :

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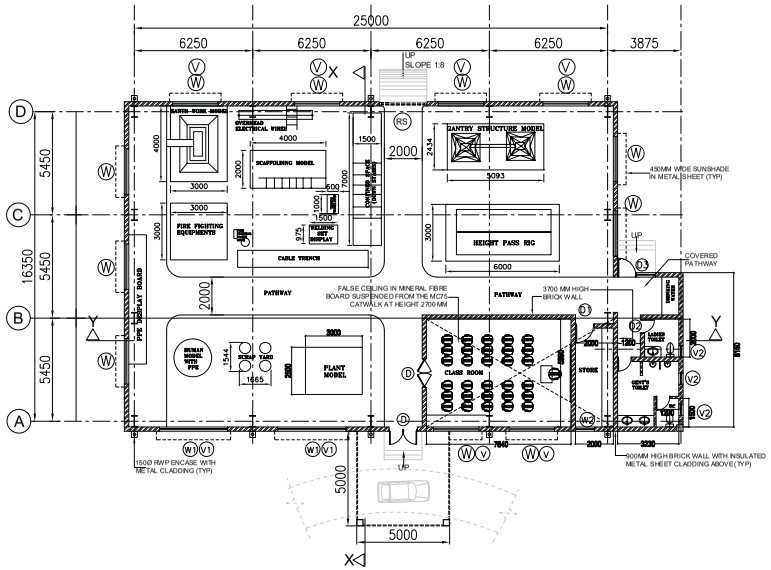
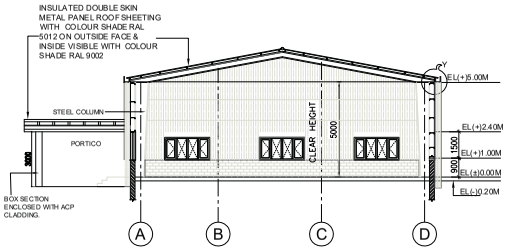
DRG. NO. 9585-001-POC-A-005 REV. NO. A





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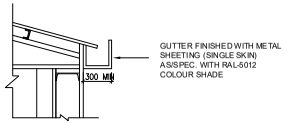

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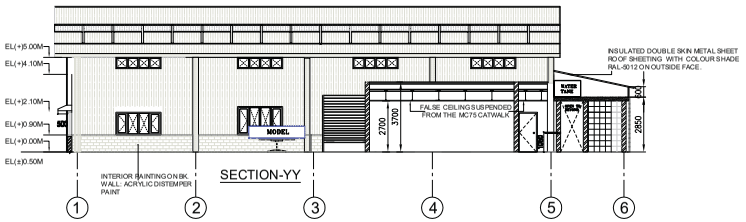

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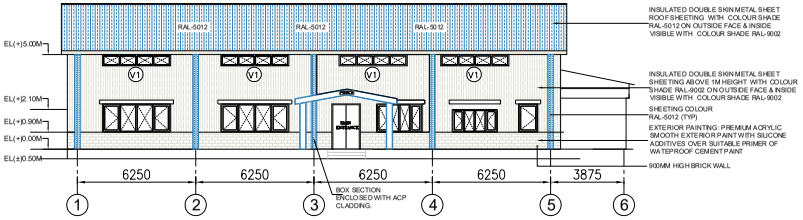

FRONT ELEVATION

SAFETY PARK

THIS BUILDING SHALL BE A SINGLE STOREYED BUILDING WITH FLOOR AREA AS / DRG. THE PLAN LAYOUT/ BUILDING PROFILE SHALL BE AS SHOWN OF PRE-ENGINEERED BUILDING TYPE WITH STEEL FRAME CONSTRUCTION AND INSULATED SANDWICH CLADDING FOR WALLS AND SANDWICHED METAL SHEET ROOFING. THE DESIGN OF THE BUILDING SHALL BE SUCH SO AS TO HAVE FASTER CONSTRUCTION OF BUILDING AND SO AS TO PROVIDE A READY TO USE BUILDING, COMPLETE AND FINISHED IN ALL RESPECTS TO THE OWNER AND SO AS TO ENABLE SHIFTING AND RELOCATION OF SUPERSTRUCTURE AT LATER DATE.

SCOPE OF WORK

1. DESIGNING, MANUFACTURING, SUPPLYING, PACKING, LOADING, TRANSPORTATION, UNLOADING, INSTALLING AND COMMISSIONING OF PRE -ENGINEERED BUILDING WITH SANDWICHED METAL SHEET WALL & ROOFING,& RAIN WATER DOWN COMER AS PER LAYOUT INCLUDING R.C.C FOUNDATIONS/PEDESTALS. (INCLUDING ANY FOUNDATION REQUIRED FOR EQUIPMENTS) EMBEDMENT OF FOUNDATION BOLTS USING TEMPLATES, ENCASEMENT OF COLUMN BASES, SUPPLY & ERECTION OF DOOR/WINDOWS/VENTILATORS/ROLLING SHUTTERS, MASONRY WORK, PLASTERING, PAINTING (INTERIOR & EXTERIOR) FLOORING, FINISHING, PAVING SLAB,PLINTH PROTECTION ETC.

2. SANDWICHED METAL SHEET FOR WALL CLADDING, ROOFING SHALL CONSIST OF TOP SHEET AS TROUGHED PERMANENTLY COLOUR COATED SHEET & BOTTOM SHEET AS PLAIN PERMANENTLY COLOUR COATED FOR COVERING OF EXPOSED METAL/ CONCRETE / BRICK SURFACES WITH 50MM THICK INSULATION SANDWICHED BETWEEN THE TWO SHEETS, EACH SHEET SHALL BE OF STEEL WITH ZINC COATED TO CLASS 275 WITH MINIMUM BARE METAL THICKNESS (I.E. EXCLUDING THE THICKNESS OF COATING AND PAINTING) OF 0.6MM OF GRADE G250 AS PER AS1397 / GRADE SS255 AS PER ASTM A653M / GRADE S250GD AS PER EN 10326 OR OF STEEL WITH ALUMINIUM-ZINC ALLOY COATED TO CLASS AZ150 WITH MINIMUM BARE METAL THICKNESS (I.E. EXCLUDING THE THICKNESS OF COATING AND PAINTING) OF 0.5MM OF GRADE G350 AS PER AS1397 / GRADE SS340 CLASS 4 AS PER ASTM A792M / GRADE S350GD AS PER EN 10326 OR OF STEEL WITH ALUMINIUM-ZINC ALLOY COATED TO CLASS AZ150 WITH MINIMUM BARE METAL THICKNESS (I.E. EXCLUDING THE THICKNESS OF COATING AND PAINTING) OF 0.4MM OF GRADE G550 AS PER AS1397 / GRADE SS550 AS PER ASTM A792M / GRADE S550GD AS PER EN 10326

3. DOOR & WINDOWS SHALL BE PROVIDED AS PER THE LAYOUT SHOWN . POWDER COATED AL. FRAMES WITH MINIMUM WALL THICKNESS OF 2 MM FOR DOORs, WINDOWS & VENTILATORS WITH 6 MM THICK TOUGHENED GLASS FOR WINDOWS AND 8 MM THICK TOUGHENED GLASS FOR GLAZED DOORS & PARTITION. MAIN ENTRANCE DOOR SHALL BE ALUMINUM GLAZED. FOR TOILET LAMINATED FLUSH DOOR SHUTTER SHALL BE PROVIDED. STEEL DOOR SHALL BE PROVIDED IN STORE ROOM. ALL THE NECESSARY ACCESSORIES AND HARDWARE SHALL BE PROVIDED. VERTICAL VENETIAN BLINDS IN PREMIUM FABRIC QUALITY SHALL BE PROVIDED FOR WINDOWS OF CLASS ROOM.

4. EXTERNAL FACE OF BRICK WALL SHALL BE FINISHED WITH 20 MM THICK PLASTER (1:5 CEMENT : SAND) AND PREMIUM ACRYLIC SMOOTH EXTERIOR PAINT WITH SILICONE ADDITIVES OVER SUITABLE PRIMER OF WATER PRROF CEMENT PAINT. INTERNAL FACE AND INTERNAL BRICK WALLS SHALL BE FINISHED WITH 12 MM THICK CEMENT SAND PLASTER (1:5) AND ACRYLIC EMULSION PAINT OVER WALL PUTTY OF MINIMUM 2 MM THICKNESS

5. FALSE CEILING IN MINERAL FIBRE BOARDS (600 X 600) SHALL BE PROVIDED IN CLASS ROOM & STORE , WHICH IS SUSPENDED FROM CATWALK CONSISTING OF MS STEEL MEMBER HAVING MAXIMUM GRID SIZE OF 1200MM X 600MM FOR SUPPORTING PANELS OF SPECIFIED SIZE. THE STEEL MEMBER SHALL BE PAINTED WITH SUITABLE PAINTING SYSTEM

6. FLOORING IN SAFETY PARK HALL SHALL BE OF MINIMUM 18 MM THICK (600MMX600MM) JHONSON ENDURA INDUSTRIAL TILES OR EQUIVALENT. FOR CLASS ROOM MATT FINISHED VITRIFIED TILE FLOORING MINIMUM 10 MM THICK(SIZE 600 MM X 600 MM) OF KAJARIA / JHONSON MAKE SHALL BE PROVIDED. TOILET SHALL BE PROVIDED WITH DUST PRESSED CERAMIC TILES FLOORING AND DESIGNER DECORATIVE CERAMIC TILE ON WALL DADO UP TO FALSE CEILING / TRUE CEILING. INTERNAL WALLS SHALL BE FINISHED WITH ACRYLIC EMULSION PAINT OVER 2MM THICK WALL PUTTY

7. ALL THE FURNITURE AS SHOWN IN LAYOUT (CHAIR & DESKS IN CLASS ROOM ETC) OF GODREJ / FEATHERLITE / JASANI OR EQUIVALENT MAKE SHALL BE PROVIDED.

8. TOILET IN WORKING CONDITION COMPLETE IN ALL RESPECTS WITH SENSOR BASED WASH BASIN SET IN GRANITE COUNTERS, DUAL FLUSH WALL HUNG W.C WITH SENSOR BASED TAPS OF JAGUAR OR EQUIVALENT. ALL THE NECESSARY ACCESSORIES OF PREMIUM QUALITY SHALL BE PROVIDED . 2 NOS. PVC OVERHEAD LOFT WATER TANK CAPACITY 500 LITER SHALL BE PROVIDED. ALL THE WALLS OF TOILET SHALL BE IN BRICK MASONRY. RUST PROOF AND LEAK PROOF PLASTIC UNDERGROUND SEPTIC TANK OF ADEQUATE CAPACITY AND OF MAKE SINTEX SEPTIC TANK OR EQUIVALENT SHALL BE PROVIDED.

9. INTELLIGENT AND ENERGY EFFICIENT LED LIGHTING WITH MINIMUM LUX LEVEL AS MENTIONED BELOW WITH RECESSED OPTIC LUMINARES / LED DOWN LIGHTERS/ MEDIUM BAY/ PENDANT LIGHT/ ASCENT LIGHT OF PHILIPS/ WIPRO/ CROMPTON GREAVES/ HAVELL OR EQUIVALENT, COMPLETE IN ALL RESPECTS WITH ASSOCIATED CABLING, FIXTURES LIKE FANS , SWITCHES, MCB, ENERGY MANAGEMENT SYSTEM LIKE DIMMERS / SENSORS ETC.
   a) CLASS ROOM.-300 LUX , DECORATIVE MIRROR OPTIC TYPE LED LUMINARIES , LED DOWN LIGHTER
   b) PORTICO:-50 LUX , INDUSTRIAL TYPE LED LUMINARIES .
   c) CORRIDOR / PASSSAGE: 50 LUX , LED LUMINARIES.
   d) BUILDING PERIPHERY LIGHTING :-50 LUX , LED LUMINARIES / LED STREET LIGHT FIXTURES.
   e) OTHER AREAS NOT COVERED ABOVE :- LIGHTING PRINCIPLES SHALL BE BASED AS MENTIONED ABOVE
   f) OTHER SPACE AREA (NONA/C AREA-200 LUX-MEDIUM BAY LED LUMINARIES)
   g) STORE- 150 LUX , LED LUMINARIES.
   h) CEILING FANS & BRACKET FAN:- TENTATIVELY ONE NUMBER OF CEILING FAN SHALL BE PROVIDED FOR 10 SQ.M AREA AT SUITABLE MOUNTING HEIGHT. FAN SHALL BE 1200MM SWEEP, CLASS -E OR BETTER INSULATED COPPER WOUND SINGLE PHASE MOTOR ALONG WITH DOWN RODS ETC.& NOS OF 400MM BRACKET CEILING FANS SHALL BE PROVIDED AT STRATEGIC LOCATIONS.

10. ADEQUATE NUMBERS OF SUPPLY / EXHAUST FANS SHALL BE PROVIDED FOR VENTILATING THE BUILDING AND TOILET AREA

11. COMPLETE CONCEALED CABLING NETWORK FOR IT - INTEGRATED BUILDING WITH INTRANET CONNECTIONS AND THE ASSOCIATED COMMUNICATION NETWORKS.

12. R.O SHALL BE PROVIDED FOR DRINKING WATER, WATER COOLERS AS SHOWN IN THE LAYOUT (OF MAKE SAMSUNG / LG / KENT/ AQUAGUARD / PANASONIC / GODREJ OR EQUIVALENT)

13. AUDIO- VISUAL EQUIPMENTS LIKE OVERHEAD PROJECTORS, DISPLAY BOARDS IN THE CLASS ROOM OF SONY/ SAMSUNG MAKE SHALL BE PROVIDED IN CLASS ROOM

EXCLUSIONS

1.SAFETY EQUIPMENTS AS SHOWN IN THE DRAWING

DOOR/WINDOW SCHEDULE

TYPE	SIZE	CILL LVL.	LINTEL LVL.	DESCRIPTION
D	1500X2400	0.00	2400	AL. GLAZED DOOR
D1	1000X2100	0.00	2100	STEEL DOOR
D2	750X2100	0.00	2100	WOODEN FLUSH DOOR WITH STEEL FRAME
D3	2000X2400	0.00	2400	AL. GLAZED DOOR
RS	2500X3000	0.00	3000	
W	2400X1500	900	2400	
W1	3600X1500	900	2400	
W2	1000X1500	900	2400	
V	3600X600	AS / ELEVATION		
V1	3600X600			
V2	600 X 600	1800	2400	

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS AND ELEVATIONS ARE IN METERS.
2. DRAWING SHALL NOT BE SCALED. ONLY WRITTEN DIMENSIONS SHALL BE FOLLOWED.
3. THE SIZE/LEVELS OF THE BUILDINGS SHOWN ARE TENTATIVE AND SHALL BE FINALIZED DURING DETAIL ENGINEERING.
4. WORK TO BE EXECUTED AS PER APPROVED FINAL WORKING DRAWING.
5. ALL THE FINISHING MATERIALS SAMPLES, COLOUR / SHADE SHALL BE GOT APPROVED FROM ENGINEER-IN-CHARGE BEFORE EXECUTION.
6. WHEREVER MULTIPLE CHOICE FOR MATERIALS MAKE HAS BEEN GIVEN, FINAL DECISION OF SELECTION OF MATERIAL MAKE RESTS WITH THE ENGINEER-IN CHARGE.

REV.NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	E	C	C&I	ARCH.	APPD	DATE
A	RELEASED FOR TENDER PURPOSE	ARCHANA	RK								30.12.16

CLEARED BY

एन टी पी सी लिमिटेड
NTPC Limited
(A GOVERNMENT OF INDIA ENTERPRISE)
(ENGINEERING DIVISION)

PROJECT: PATRATU SUPER THERMAL POWER PROJECT
STAGE-1 (3 X 800MW)

TITLE: SAFETY PARK
ARCHITECTURAL DETAILS & SPECIFICATIONS

SIZE	SCALE	DRG. NO.	REV. NO.
A1	1:100	9585-001-POC-A-005	A

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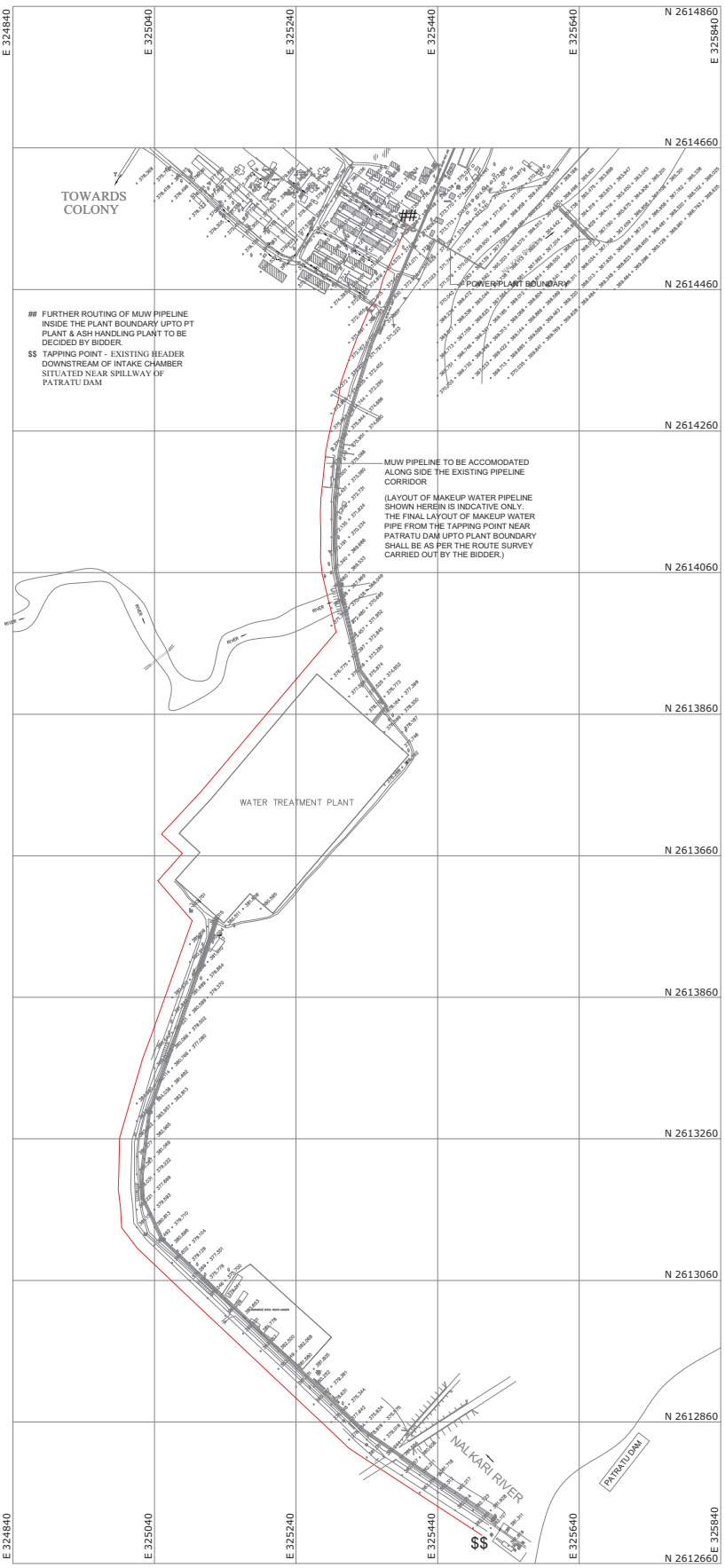


FURTHER ROUTING OF MUW PIPELINE INSIDE THE PLANT BOUNDARY UPTO PT PLANT & ASH HANDLING PLANT TO BE DECIDED BY BIDDER.

$$ TAPPING POINT - EXISTING HEADER DOWNSTREAM OF INTAKE CHAMBER SITUATED NEAR SPILLWAY OF PATRATU DAM

MUW PIPELINE TO BE ACCOMODATED ALONG SIDE THE EXISTING PIPELINE CORRIDOR

(LAYOUT OF MAKEUP WATER PIPELINE SHOWN HEREIN IS INDCATIVE ONLY. THE FINAL LAYOUT OF MAKEUP WATER PIPE FROM THE TAPPING POINT NEAR PATRATU DAM UPTO PLANT BOUNDARY SHALL BE AS PER THE ROUTE SURVEY CARRIED OUT BY THE BIDDER.)

N (MAGNETIC NORTH)
W E
S

WATER PIPE LINE MAP

SCALE:- 1 : 3000

30 15 0 30 60 90 120

DETAIL TOPOGRAPHIC SUR EY PLAN FOR PATRATU SUPER THERMAL POWER PRO ECT(800MW). AT PATRATU DIST. RAMGARH STATE:- HARKHAND

LEGENDS

SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
	PROPOSED PLANT BOUNDARY		TEMPORARY BENCH MARK
	EXISTING PLANT BOUNDARY		TELEPHONE TOWER
	SURVEY AREA BOUNDARY		HIGH TENSION TOWER
	ASPHALT ROAD EDGE		ELECTRIC DP.
	WBM ROAD EDGE		ELECTRIC POLE WITH LINE (LT)
	CART TRACK EDGE /EARTHEN ROAD		STREET LIGHT
	CEMENT ROAD EDGE		TELEPHONE POLE
	MEDIAN (DIVIDER)		TELEPHONE_DP
	NALLA		TEMPLE,CURCH
	POND		BORE HOLE
	RIVER		BRIDGE
	RAILWAY_LINE		CULVERT
	HIGH TENSION LINE		WATER TAP
	COMPOUND WALL		WATER TANK
	FENCING		WATER PIPELINE AIR VALVE
	DRAIN CENTER		WATER PIPELINE
	DRAIN EDGE(CONST & NATURAL)		WELL (LINED)
	QUARRY		STATUS
	POST BOX		FOCUS LIGHT
	HAND PUMP		RAILWAY LINE ELECTRIC POLE
	FLAG POST		VILLAGE BOUNDARY
FS	FOREST BOUNDARY STONE		TREE
KM	KM STONE		TOWER
	FIRE VALVE		COAL YARD

REV.NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	E	C	C&I	ARCH.	APPD	DATE
B	RELEASED FOR TENDER PURPOSE ONLY	DEEP	AAT								28.09.17
A	RELEASED FOR TENDER PURPOSE ONLY	DEEP	AAT								09.12.16

CLEARED BY

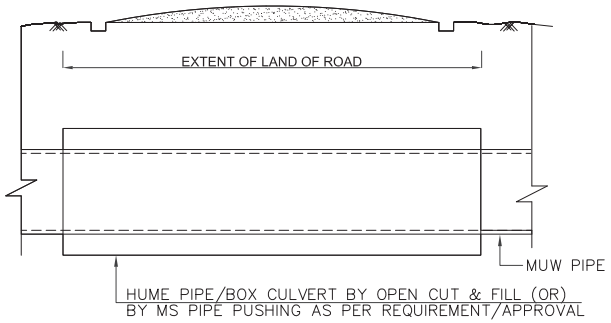
NTPC LIMITED
(A GOVERNMENT OF INDIA ENTERPRISE)
ENGINEERING DIVISION

PROJECT: PATRATU SUPER THERMAL POWER PROJECT
EXPANSION PHASE-I (3x800 MW)

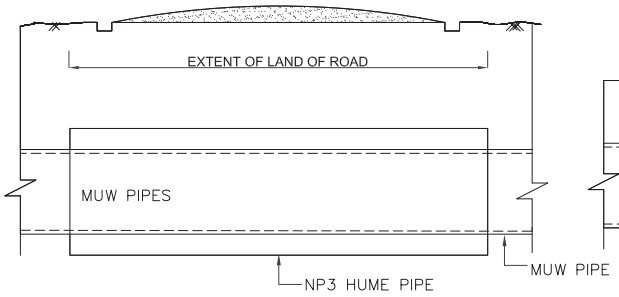
PACKAGE: EPC PACKAGE

TITLE: TYPICAL LAYOUT OF MAKE-UP WATER PIPELINE

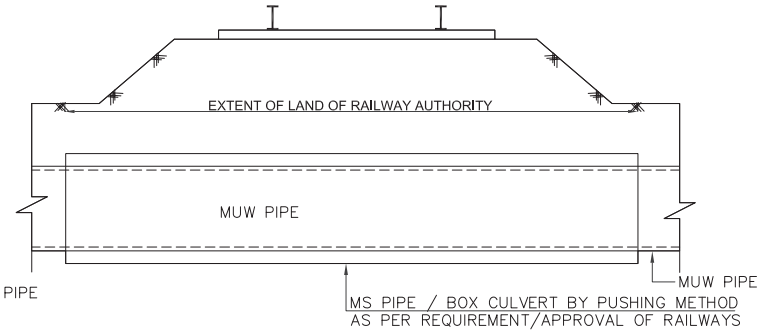
SIZE: A0 | SCALE: N.T.S. | DRG. NO.: 9585-001-POC-A-006 | REV. NO.: B



TYPICAL DETAILS AT NH/SH/PUCCA ROAD CROSSING

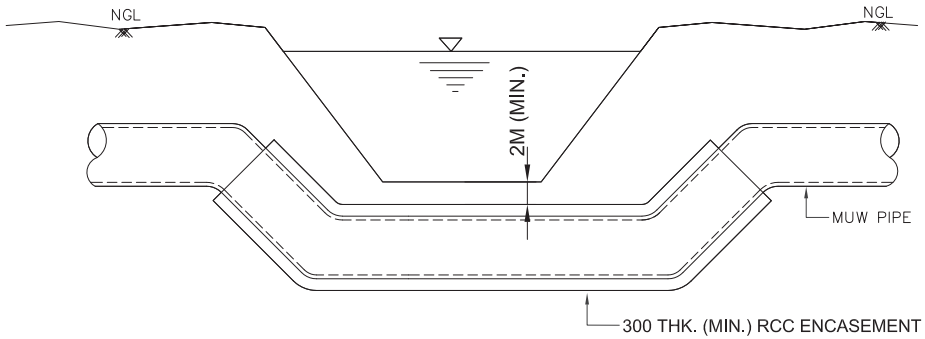


TYPICAL DETAILS AT KUCCHA VILLAGE ROAD CROSSING

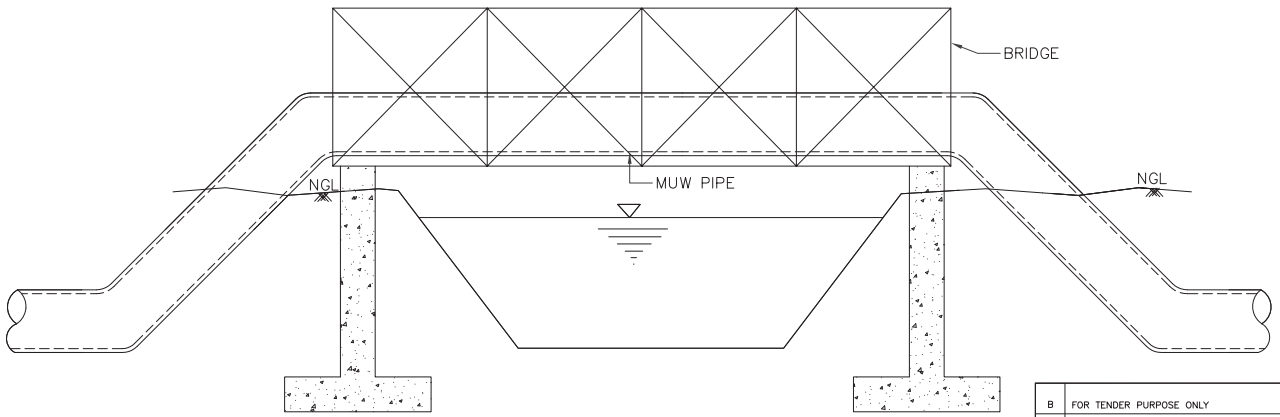


TYPICAL DETAILS AT RAIL CROSSING

(THE CONTRACTOR SHALL APPOINT RAILWAY APPROVED CONSULTANT FOR DESIGNING, OBTAINING APPROVAL FROM RAILWAYS AND EXECUTION OF CULVERT)



TYPICAL DETAILS OF BURRIED PIPE CROSSING AT CANAL / NALA / NON-PERENNIAL WATERWAYS



TYPICAL DET. OF OVER GROUND PIPE CROSSING AT PERENNIAL RIVER / WATERWAYS & MAJOR IRRIGATION CANALS

(MIN. 1.0M WIDE PATHWAY SHALL BE PROVIDED ON THE BRIDGE FOR PIPE MAINTENANCE)

NOTES:

1. THE DETAILS SHOWN ARE INDICATIVE AND MAY CHANGE DURING DETAIL ENGINEERING

FOR TENDER PURPOSE ONLY

REV.NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	E	C	C&I	ARCH.	APPD	DATE
B	FOR TENDER PURPOSE ONLY	DEEP	AAT								25.04.17
A	FOR TENDER PURPOSE ONLY	DEEP	AAT								12.05.16

CLEARED BY

NTPC Limited
(A GOVERNMENT OF INDIA ENTERPRISE)
ENGINEERING DIVISION

PROJECT: PATRATU SUPER THERMAL POWER PROJECT
EXPANSION PHASE-I (3x800 MW)

PACKAGE: EPC PACKAGE

TITLE: TYPICAL DETAILS OF MAKE-UP WATER PIPELINE CROSSINGS

SIZE	SCALE	DRG. NO.	REV. NO.
A2	NTS	9585-001-POC-A-007	B

CAD FILE NAME :

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Annexure-1

7.00.0 FOUNDATION SYSTEM AND GEOTECHNICAL DATA

7.01.0 Soil Data

Owner has carried out preliminary geotechnical investigation at the project site. Available borelogs along with laboratory test results, are enclosed at Annexure-C for Bidder's reference. The preliminary geotechnical investigation report for these areas will be made available for the Bidder's study at the Owner's office, if required.

Onus of correct assessment/ interpretation and understanding of the existing subsoil condition / data is on the Bidder. Bidder may refer topographical survey drawing for variation in existing ground level.

7.01.01 Contractor shall carryout detailed soil investigation for the facilities under this package. The scheme for geotechnical investigation shall be as given at **Clause 7.08.00** and shall be approved by Owner before execution. Geotechnical investigation work shall be got executed by the contractor through the agencies as mentioned in Clause No. 7.07.00. The geotechnical investigation report shall be prepared with detailed recommendations regarding type of foundation and allowable bearing pressure for various structures/ facilities and other soil parameters. The report shall be submitted for Owner's approval prior to commencement of design of foundation.

7.01.02 The Bidder should note that nothing extra whatsoever on account of variation between soil/rock data collected by Owner and that found by the contractor during detailed geotechnical investigation by him or during execution of works, shall be payable.

7.01.03 Tank Foundations

a) The tanks shall rest on flexible tank pad foundation, resting on sand with concrete ring wall to retain sand. Base of the concrete ring wall shall not rest on the expansive soil, if any.

b) Entire loose/ soft soil inside the concrete ring wall shall be removed and shall be filled with sand. Sand for filling shall be clean and well graded conforming to IS 383 with grading Zone I to III.

c) Sand shall be spread in layers not exceeding 30cm compacted thickness over the area. Each layer shall be uniformly compacted by mechanical means like plate vibrators, small vibratory rollers, etc to achieve a relative density of not less than 80%.

d) Other requirements of tank foundations shall be as per IS 803 and as specified elsewhere in the specifications.

7.02.00 **Foundation System**

The requirements for the foundation system to be adopted are as given in subsequent clauses. Depending upon the depth of competent strata/stratum, type of structures, functional requirement of facility, extent of cutting / filling, suitable foundation, open or pile shall be adopted with approval of owner.

7.02.01 **General Requirements**

a) All structures/equipment shall be supported either on suitable open foundations (isolated, combined, raft) or pile foundations depending on type of structures/facilities, sub-strata, topography etc.

b) The roads, ground floor slabs, trenches, pipe pedestals, channels/drains and staircase foundation with foundation loading intensity less than 4 T / M2 may be supported on open / shallow foundations resting on virgin / controlled compacted filled up soil.

c) No other foundation (other than as mentioned in (b) above) shall rest on the filled up ground / soil.

d) All foundations shall be designed in accordance with relevant parts of the latest revisions of Indian Standards.

e) The water table for design purpose shall be considered at Finished Ground Level.

f) A combination of open and pile foundations shall not be permitted under the same equipment / structure / building.

g) Foundation for equipments on ground floor

For equipments of static weight upto 1.5 T, the equipment may be supported on the ground floor slab by locally thickening the slab. Thickening of the ground floor slab shall be done upto an extent of about 0.6 m beyond the plan area of the equipment on all the sides. Further, the load intensity below the equipment shall be limited to 4T/m2. Other requirements of floor slab and compaction below the floor slab shall be adhered, as specified elsewhere in the specifications.

For equipment of static weight more than 1.5 T, the equipment foundation shall be taken to the founding level or shall be built up with PCC from the level as mentioned in the Table 1. The pedestal of equipment foundation or the foundation Block shall be isolated from the adjoining floor slab by providing bitumen impregnated fiber board of minimum 50 mm thick, conforming to IS: 1838 all around the equipment pedestal for the full depth of the floor slab.

7.02.02 **Open Foundations**

In case open foundations are adopted, following shall be adhered to.

a) The minimum width of foundation shall be 1.0 m.

b) Minimum depth of foundation shall be 1.0m below Ground Level.

c) It shall be ensured that all foundations of a particular structure/ buildings/ facility shall rest on one bearing stratum.

d) Wherever the intended bearing sub-strata is virgin soil stratum but the actual stratum encountered during foundation excavation consists of filled up soil at founding level, under such cases either the foundation shall be lowered completely into the virgin

stratum or the filled up soil upto the virgin layers shall be removed and built up through PCC (1:4:8) up to designed foundation level.

e) Contractor shall carry out detailed geotechnical investigation, the maximum allowable bearing pressure shall be as per the approved geotechnical report and shall be limited to the values as furnished in Table-1.

Table-1

Founding Depth/ Stratum	Net Allowable Bearing Pressure T/m2		
	Isolated and combined footings including raft for 25mm permissible settlement in case of soil and 12mm in case of rocky strata	Isolated and combined footings for 40mm permissible settlement in case of soil and 12mm in case of rocky strata	Rafts (width > 6m) for 75mm permissible settlement in case of soil and 12mm in case of rocky strata
	Width upto 6.0m		
In case of foundation stratum is soil			
1.0m below NGL	-	8	10
2.0m below NGL	-	12	15
3.0m below NGL	15	18	20
In case of founding stratum is rock			
0.5m embedment into very dense sand with SPT 'N' Value more than 60 and upto 100	30	35	35
1.0m embedment into disintegrated rock, into very dense sand with SPT 'N' Value more than 100	40.0	40.0	40.0
2.0m embedment into disintegrated rock	50.0	50.0	50.0

In case any loose/soft pockets in rocky strata is encountered at founding level, the same shall be removed completely upto the hard strata and filled up with PCC (1:4:8).

f) For open foundations, the total permissible settlement shall be governed by IS: 1904 / IS: 13063 and from functional requirements whichever is more stringent. However, total settlement shall be restricted to the following:

Isolated & Raft (Main power house, TG Area Footings, Boiler, Mill, Bunker Footings & Fans) resting on soil	25 mm
Isolated & Strip (other than Main power house, TG Area Footings, Boiler, Mill, Bunker Footings & Fans) resting on soil	40 mm
Raft (other than Main power house, TG Area Footings, Boiler, Mill, Bunker Footings & Fans) resting on soil	75 mm
Foundations in Weathered rock / rock	12 mm

Incase pile foundations are to be adopted the requirements under para "Pile Foundations" shall be adhered to.

7.02.03 Pile Foundations –

In case piles are adopted, following shall be adhered to :

i) The pile foundation shall be of RCC, Cast-in-situ bored piles as per IS:2911. Pile boring shall be done using Rotary Hydraulic Rigs. Two stage flushing of pile bore shall be ensured by airlift technique duly approved by the Employer.

If required, temporary or permanent MS liner may be provided for piling.

ii) The minimum diameter of pile shall be 600 mm. The allowable load capacity of the pile in different modes (vertical compression, lateral and pullout) shall be as per approved geotechnical report & shall be limited to the values given below:

Pile	Dia. (mm)	Vertical compression capacity (T)
Bored cast-in-situ pile	600	140
	760	250

The piles shall be socketed 5m (minimum) into rock.

The uplift and lateral load capacity shall be respectively restricted to 35% and 5% of the allowable load capacity in vertical compression.

However, the pile capacities to be adopted shall be the least of the estimated design values and that obtained from the initial pile load tests.

iii) Only straight shaft piles shall be used. Minimum cast length of pile above cutoff level shall be 1.0 m.

iv) The contractor shall furnish design of piles (in terms of rated capacity, length, diameter, termination criteria to locate the founding level for construction of pile in terms of measurable parameter, reinforcement for job as well as test piles, pile load test arrangement, locations of initial test piles etc.) for Engineer's approval.

v) The piling work shall be carried out in accordance with IS:2911 (Relevant part) and accepted construction methodology. The construction methodology shall be submitted by the Contractor for Engineer's approval.

vi) Number of initial load tests to be performed for each diameter and rated capacity of pile shall be subject to minimum as under.

Vertical

Lateral Minimum of 4 Nos. in each mode.

Uplift

vii) The initial pile load test shall be conducted with test load upto three times the estimated pile capacity. In case of vertical compression test (initial test) the method of loading shall be cyclic as per IS:2911 (relevant part).

viii) Load test shall be conducted at pile Cut-off Level (COL). If the water table is above the COL the test pit shall be kept dry throughout the test period by suitable de-watering methods. Alternatively the vertical load test may be conducted at a level higher than COL. In such a case, an annular space shall be created to remove the effect of skin friction above COL by providing an outer casing of suitable diameter larger than the pile diameter.

ix) Number of routine pile load tests to be performed for each diameter/allowable capacity of pile shall be as under :

i) Vertical : 0.5% of the total number of piles provided.

ii) Lateral : 0.5% of the total number of piles provided.

x) The routine tests on piles shall be conducted upto test load of one and half times the allowable pile capacity. Piles for routine load tests shall be approved by the Employer.

xi) In case, routine pile load test shows that the pile has not achieved the desired capacity or pile(s) have been rejected due to any other reason, then the Contractor shall install additional pile(s) as required and the pile cap design shall accordingly be reviewed and modified, if required.

xii) Testing of piles and interpretation of pile load test results shall be carried out as per IS:2911 (Part-4). Contractor shall ensure that all the measuring equipment and instruments are properly calibrated at a reputed laboratory / institute prior to their use. Settlement / movement of the pile top shall be made by Linear Variable Differential Transducers (LVDT) having a least count of 0.01mm.

xiii) The test load on initial test piles shall be applied by means of reaction from anchor piles / rock anchors alone or combination of anchor piles / rock anchors and kentledge with concrete blocks.

xiv) Low Strain Pile Integrity test shall be conducted on all test piles and job piles. This test shall be used to identify the routine load test and not intended to replace the use of static load test. This test is limited to assess the imperfection of the pile shaft and shall be undertaken by an independent specialist agency to be approved by Engineering department of Owner. The test equipment shall be of TNO or PDI make or equivalent. The process shall confirm to ASTM.

xv) High Strain Dynamic Load Test may be carried out for routine load testing of working piles. However, at least three numbers of static routine vertical load tests shall be carried out on pile on which high strain dynamic load test has already been carried out for establishing the correlation between the two tests. In case of discrepancy if any between dynamic and static vertical load tests, then additional static routine vertical load tests shall be conducted as decided by the Engineer and the results of static routine vertical load shall prevail. Number of routine vertical pile load tests as per clause 7.02.03 (ix) shall be total of static routine vertical load test and high strain dynamic load tests.

The procedure to carry out the test shall be submitted to the Engineer. The test and equipment shall conform to ASTM D4945-00. The test shall be conducted by an experienced independent test agency approved by the owner. Field data shall be submitted to the site engineer and shall include force velocity curves, pile capacity, simulated static load test curve, net and total pile displacement, pile integrity. A (Case pile wave analysis) CAPWAP or equivalent software analysis shall be conducted on the field data for correct capacity estimation and to evaluate end bearing and skin friction components of the pile.

xvi) From load considerations, single pile may be used under a column/tower. In that case, pile shall be connected with tie beams at pile cut off level in both directions.

xvii) Contribution of frictional resistance of filled up soil if any, shall not be considered for computation of frictional resistance of piles.

xviii) Reinforcement for job piles shall be designed as following:

(a) Compression + bending piles: For these piles, the allowable safe pile capacities in compression and bending shall be considered.

(b) Tension + bending piles: For these piles, the actual pile forces to be considered. However, maximum 3 types of combinations for varying percentage of tension capacity + bending case may be designed & adopted by contractor for the entire scope of work under this package.

7.02.04 **Foundations in switchyard Area:**

As per General layout plan & topographical survey, major portion of switchyard involves filling varying upto maximum 12m depth to achieve the specified finished formation level. A small portion of the switchyard involves cutting of ground to achieve the specified formation level. Considering the filling involved, contractors may adopt either of following proposed foundation system.

i) Open Foundations for buildings, towers & equipments to be designed resting below NGL as per the criteria as mentioned in Table-1.

or

ii) Pile foundations for buildings, towers & equipments: Piles to be provided as per criteria specified above.

7.03.00 **Special Requirements**

7.03.01 Details of treatment for foundations / underground structures required to counteract soil / water chemical environment shall be as per detailed geotechnical investigation to be carried out by contractor. Contractor shall carry out chemical analysis during detailed geotechnical investigation and required treatment shall be provided accordingly.

7.04.00 **Excavation, Filling and Dewatering**

7.04.01 For excavation works, comprehensive dewatering with well point or deep wells arrangement, if required, shall be adopted. Scheme for dewatering and design with all computations and back up data for dewatering shall be submitted for the owner's information. The water table shall be maintained at 0.5m below the founding depth.

7.04.02 Excavation for shallow foundations shall be covered with PCC immediately after reaching the founding level. In case of any local loosening of soil or any loose pockets are encountered at founding level during excavation the same shall be removed and compensated by PCC M7.5. The final layer of about 300 mm thickness above the founding level shall be excavated by suitable means, so as to avoid disturbance to founding stratum.

7.04.03 **Backfilling in Power House & Boiler Area**

Backfilling around foundations, trenches, sumps, pits, plinths, etc. shall be carried out with sand in layers not exceeding 300 mm compacted thickness and each layer shall be compacted to minimum 80% of relative density.

Backfilling in other area

Backfilling around foundations, pipes, trenches, sumps, pits, plinths, etc. shall be carried out with approved material in layers not exceeding 300 mm compacted thickness (higher thickness of layers upto 500mm with heavy mechanical compacting equipment) and each layer shall be compacted to 90% of standard proctor density for cohesive soils and to 80% of relative density for non cohesive soils.
Rock pieces having size less than 150 mm and interstices filled with soil may be used for backfilling around foundation, plinths etc. and shall be compacted to minimum of 85% of original stack of material after filling the interstices.

7.04.04 Founding level for trenches/channels shall be decided as per functional requirement. The bottom of excavation shall be properly compacted prior to casting of bottom slab of trenches / channels.

7.04.05 CBR (California bearing ratio) tests for pavement/road design shall be carried out by the Contractor after earth filling (if applicable) has been completed upto the formation level.

7.04.06 The contractor shall take all necessary measures during excavation to prevent the hazards of falling or sliding of material or article from any bank or side of such excavation which is more than one and a half meter above the footing by providing adequate piling, shoring, bracing etc. against such bank or sides.

Adequate and suitable warning signs shall be put up at conspicuous places at the excavation work to prevent any persons or vehicles falling into the excavation trench. No worker should be allowed to work where he may be stuck or endangered by excavation machinery or collapse of excavations or trenches.

7.05.00 EXCAVATION IN ROCK

Excavation in rock shall be carried out by mechanical means and if blasting is required for founding of some of the structures under this package, control blasting only shall be carried out.

7.05.01 Controlled blasting shall be done by a specialised agency duly approved by Engineer. All controlled blasting shall be done by using time delay detonators (i.e. excel type).

7.05.02 a) Contractor shall engage an agency expert in blasting such as, NIRM (National Institute of Rock Mechanics), CMPDIL, Central Institute of Mining and Fuel Research Dhanbad, Dept. of Mining of Govt. Institutions etc. to design detailed blasting scheme and get the same approved from Engineer before carrying out the blasting operation. All blasting shall be done as per the approved blasting scheme & initial blasting operations shall be done under the supervision & guidance of the representative of the blasting expert.

b) All the statutory laws, (Explosives Act etc.) rules, regulations, Indian Standards, etc. pertaining to the acquisition, transport, storage, handling and use of explosives, etc. shall be strictly followed.

c) The Contractor shall obtain Licenses from Competent Authorities for undertaking blasting work as well as for procuring, transporting to site and storing the explosives as per explosives act. The Contractor shall be responsible for the safe transport, use, custody and proper accounting of the explosive Materials.

d) The Contractor shall be responsible and liable for any accident and injury / damage which may occur to any person or property of the project or public on account of any

operations connected with the storage, transportation, handling or use of explosive and blasting operations.

7.06.00 Sheeting & Shoring

The contractor shall ascertain for himself the nature of materials to be excavated and difficulties, if any, likely to be encountered in excavation while executing the work. Sheet piling, sheeting and shoring, bracing and maintaining suitable slopes, drainage, etc. shall be provided and installed by the Contractor, to the satisfaction of the Engineer.
For deep excavation in CHP area, sheet piling / contiguous pile / secant pile / diaphragm walls may be required depending upon the proximity to the existing facilities. The excavation design & scheme shall be developed by a specialized agency.

7.07.00 Geotechnical Investigation

The Contractor shall carry out detailed geotechnical investigation in the areas under his scope for establishing the sub-surface conditions and to decide type of foundations for the structures envisaged, construction methods, any special requirements/treatment called for remedial measures for sub-soil/ foundations etc. in view of soft sub-soils, aggressive sub-soils and water, expansive/swelling soils etc. prior to commencement of detailed design/drawings. The Contractor shall obtain the approval for the field testing scheme proposed by him from the Owner before undertaking the geotechnical investigation work.

7.07.01.00 **Scheme of geotechnical Investigation**

7.07.02.01 Field test shall include but not be limited to the following:

Boreholes, Standard Penetration Test (SPT), Dynamic Cone Penetration Test (DCPT), collection of disturbed samples (DS) and undisturbed soil samples (UDS), Trial Pits (TP), Plate Load Tests (PLT),Cyclic Plate Load Test(CPLT), Electrical Resistivity Test (ERT), Cross Hole Test, Pressure Meter Test (PMT), In situ field permeability tests, collection of water samples, etc.

7.07.02.02 The diameter of borehole shall be minimum 150 mm in soil and 76 mm in rock. The diameter of UDS sampler shall be 100 mm minimum. Core drilling in rock shall be done by using hydraulically feed rotary drill & double tube core barrel with diamond bit.

7.07.02.03 The minimum tests are indicated in Clause No**. 7.08.00.** Adequate number of tests shall be conducted up to sufficient depth for complete determination of subsoil conditions. The depth of boreholes shall be as specified in Clause No. 7.08.00. SPT shall be carried out in all types of soil deposits and in all rock formations with core recovery up to 20%, met within a borehole. This test shall be conducted at every 3.0 m interval or at change of strata, up to the final depth. SPT 'N' of 100 and above shall be referred as refusal. UDS shall be collected at every 3.0 m interval or at change of strata up to depth of borehole. UDS may be replaced by additional SPT, if SPT'N' value in the strata is above 50.

7.07.02.04 Laboratory tests shall be done as per relevant IS codes. The laboratory tests, not be limited to the following shall be conducted on disturbed and undisturbed soil samples, rock samples & water samples collected during field investigations in sufficient numbers.

Laboratory Tests on Soil Samples

Laboratory tests shall be carried out on disturbed and undisturbed soil samples for Grain Size Analysis, Hydrometer Analysis, Atterberg Limits, Triaxial Shear Tests (UU), Natural Moisture Content, Specific Gravity and Bulk Unit Weight, Consolidation Tests, Unconfined Compression Test, Free swell Index, Shrinkage Limit, Swell Pressure Test, Chemical Analysis test on soil and water samples to determine the carbonates, sulphates, chlorides, nitrates, pH, organic matter and any other chemicals harmful to concrete and reinforcement/ steel.

Laboratory Tests on Rock Samples

Moisture content, porosity & density, Specific Gravity, Hardness, Soundness, Slake durability index, Unconfined compression test (Both at saturated and in-situ water content), Point load strength index and deformability test (Both at saturated and in-situ water content) shall be carried out on rock samples.

7.07.02.05 Geotechnical investigation (field & laboratory) shall be carried out in accordance with the provisions of relevant Indian Standards.

On completion of all field & laboratory work, geotechnical investigation report shall be submitted for Owner's review/approval. The Geotechnical investigation report shall contain geological information of the region, procedure adopted for investigation, field & laboratory observations/ data/ records, analysis of results & recommendations on type of foundation for different type of structures envisaged for all areas of work with supporting calculations. Recommendations on treatment for soil, foundation, based on subsoil characteristics, soft soils, aggressive chemicals, expansive soils, recommendation along with slope stability calculation for deep excavation, etc.

Recommendations on foundation system and the net allowable bearing pressures and pile capacity shall be based on the conservative values of geotechnical investigation data.

Special requirements for river side/submergence facilities

Contractor may provide suitable foundations as per IRC. The design of river/water body side foundations shall account for local scour around foundations, which shall be assessed by Contractor. Scour calculation shall be as per IRC.

7.07.03.00 Geotechnical investigation work shall be got executed by the Contractor through the following agencies.

1. C.E.TESTING COMPANY Pvt. Ltd, Kolkata
2. Cengrs Geotechnica Pvt. Ltd, New Delhi
3. M.K. Soil Testing Laboratory, Ahemdabad
4. SECON Pvt Ltd, Bangalore
5. Soil Engineering Consultants, New Delhi
6. Orbital Infrastructure Consultancy & Research Pvt. Ltd. Cuttack
7. KCT Consultancy Services, Ahemdabad
8. ARKITECHNO Consultants (India) Pvt. Ltd. Bhubaneswar

7.08.00 Geotechnical Investigation Scheme

a) Boreholes (Minimum)

S.No	Structure	Spacing/Number of borehole	Depth of borehole	Remarks
1	Main power house, Turbo-Generator (TG)	35 to 45 m along the rows of main power house columns. Minimum 2 boreholes under each TG	Depth of boreholes shall be 25m to 30m.	**Depth of boreholes shall be as mentioned in column "Depth of Borehole" or 5m continuous in rock with RQD > 50% whichever is earlier.**
2	Main Plant structures (Boiler, ESP, Chimney, Mills, Fans etc)	Minimum 3 boreholes under each Boiler, Mill & Bunker, ESP structure and 4 boreholes under Chimney, Minimum 2 boreholes under each ESP Control Room, TPs, Fans and Duct Support.	Depth of boreholes shall be 25m to 30m.	
3	Service Building	Minimum 2 no of boreholes	20 to 25 m	
4	CPU Building	Minimum 2 no of boreholes	15 to 20m	
5	Flue Gas Ducting and Absorber Area (FGD)	Minimum 15 boreholes	20 to 25m	
6	Ash Handling Structures	Minimum 8 boreholes	20 to 25 m	
7	Corridors for Ash Conveyors& Make-up water pipeline	1 borehole @ 500 m c/c along the identified corridor and one ERT shall be conducted near each borehole in Ash conveyors.	8-10 m	
8	Crossings along the Ash Conveyor, Makeup water pipeline corridor like road, river, nallah/ canal, Approach bridge	2 no. of boreholes at each crossing (one on each side) and 2 nos (min) of boreholes inside the river/ nallah of width more than 10.0m	20 to 30m	

9	Air cooled condenser (ACC)	Minimum 10 no of boreholes	25 to 30 m	
10	Switchyard	Minimum 10 No of Boreholes and 8 No of ERT	10 to 15 m	
11	Coal Handling Plant	Minimum 1 borehole under each TP and 1 under each crusher and 1 borehole under each structure. Minimum 10 no of under each stockpile area, 1 in each WT	20 to 30 m	
12	Transformer yard	Minimum 8 boreholes and 8 No of ERT	10 to 15 m	
13	Water and effluent treatment and disposal plant	Minimum 6 no of borehole	10 to 20 m	
14	Pump houses, Control room building, swgr room etc.	4 Nos. boreholes, 3 Nos. ERT and 1 no PLT		
15	Fuel oil unloading and storage system	Minimum 2 Nos.	10 to 20 m	
16	Township	Minimum 8 Nos.	20 to 25 m	
17	Ash Mound Area	Minimum 15 Nos.	10 to 20 m	
18	Other Structure/Facility	Minimum 2 Nos. boreholes under each area / facility	15 to 20 m	
b) Other Field Tests (Minimum)				

1	Plate Load Test (PLT)	2 no in Power House, 3 Nos. in boiler area, 1 No. in CPU, 1 no each in each ESP and 3 Nos. in Ash Handling Structure area in Plant Area, 6 No in Balance of Plant area	Test Depth from 2 to 4 m	
2	Cyclic Plate Load Test (CPLT)	1 no in each TG, 1 no in each Mill, 1 no in ID fan, 1 no in each FGD	Test Depth from 2.5 to 4 m	
3	Trial Pit (TP)	About 35 Nos.	Depth - 4 m	
4	In Situ Permeability Test In Boreholes	In minimum 35 Nos. of boreholes	Tests shall be conducted at depths of 1.0m, 3.0m, 5.0m, 8.0m and 10.0m in other than Wagon Tippler area. In Wagon Tippler area test shall be conducted at depths of 1.0m, 4.0m,7.0m, 10.0m, 13.0m,16.0m and 20.0m	
5	DCPT	About 10-20% of boreholes up to refusal depth		
6	ERT	6 Nos. in TG/Power House area, 6 nos. in Air cooled condenser, 1 No. in CPU Building, 2 Nos. each in Boiler, Chimney, ESP Control Room, 4 Nos. in Ash Handling Structures area in Plant area, 2 Nos in each FGD. 1No near each Pump		

		House other than mentioned above		
7	CROSS-HOLE TEST	1No. in each TG, 1No. in each Mill & bunker and 2 Nos in ID Fan, 1 no in each FGD	Depths covering from 1.0 m to 15.0 m	
8	PMT	80 no of tests in power house area, SG area & Balance of Plant area	Depths covering from 1.0 m to 20.0 m	

- Depth and location of Boreholes and other field tests (DCPT, PLT, CPLT, Cross-Hole Test, ERT, PMT, field permeability tests etc.) shall be approved by Owner before execution of geotechnical investigation work.

Investigation in any other building / structure / facilities / trestles and associated works / items, which are not listed above shall also be carried

Annexure-2

CRITERIA FOR EARTHQUAKE RESISTANT DESIGN OF STRUCTURES AND EQUIPMENT

All structures and equipment shall be designed for seismic forces adopting the site specific seismic information provided in this document and using the other provisions in accordance with IS:1893 (Part 1 to Part 4). Pending finalization of Part 5 of IS:1893, provisions of part 1 shall be read along with the relevant clauses of IS:1893:1984, for embankments.

A site specific seismic study has been conducted for the project site. The peak ground horizontal acceleration for the project site, the site specific acceleration spectral coefficients (in units of gravity acceleration 'g') in the horizontal direction for the various damping values and the multiplying factor (to be used over the spectral coefficients) for evaluating the design acceleration spectra are as given at Appendix-I.

Vertical acceleration spectral values shall be taken as 2/3rd of the corresponding horizontal values.

The site specific design acceleration spectra shall be used in place of the response acceleration spectra, given at figure-2 in IS:1893 (Part 1) and Annex B of IS:1893 (Part 4). The site specific acceleration spectra along with multiplying factors specified in Appendix-I includes the effect of the seismic environment of the site, the importance factor related to the structures and the response reduction factor. Hence, the design spectra do not require any further consideration of the zone factor (Z), the importance factor (I) and response reduction factor (R) as used in the IS:1893 (Part 1 to Part 4).

Damping in Structures

The damping factor (as a percentage of critical damping) to be adopted shall not be more than as indicated below for:

a)	Steel structures	:	2%
b)	Reinforced Concrete structures	:	5%
c)	Reinforced Concrete Stacks	:	3%
d)	Steel stacks	:	2%

Method of Analysis

Since most structures in a power plant are irregular in shape and have irregular distribution of mass and stiffness, dynamic analysis for obtaining the design seismic forces shall be carried out using the response spectrum method. The number of vibration modes used in the analysis should be such that the sum total of modal masses of all modes considered is at least 90 percent of the total seismic mass and shall also meet requirements of IS:1893 (Part 1). Modal combination of the peak response quantities shall be performed as per Complete Quadratic Combination (CQC) method or by an acceptable alternative as per IS:1893 (Part 1).

In general, seismic analysis shall be performed for the three orthogonal (two principal horizontal and one vertical) components of earthquake motion. The seismic response from the three components shall be combined as specified in IS:1893 (Part 1).

The spectral acceleration coefficient shall get restricted to the peak spectral value if the fundamental natural period of the structure falls to the left of the peak in the spectral acceleration curve.

For buildings, if the design base shear (V_B) obtained from modal combination is less than the base shear ($\bar{V}_B$) computed using the approximate fundamental period (T_a) given in IS:1893:Part 1 and using site specific acceleration spectra with appropriate multiplying factor, the response quantities (e.g. member forces, displacements, storey forces, storey shears and base reactions) shall be enhanced in the ratio of $\bar{V}_B / V_B$. However, no reduction is permitted if $\bar{V}_B$ is less than V_B.

For regular buildings less than 12m in height, design seismic base shear and its distribution to different floor levels along the height of the building may be carried out as specified under clause 7.5, 7.6 & 7.7 of IS:1893 (Part 1) and using site specific design acceleration spectra. The design horizontal acceleration spectrum value (Ah) shall be computed for the fundamental natural period as per clause 7.6 of IS:1893 (Part 1) using site specific spectral acceleration coefficients with appropriate multiplying factor given in Appendix-I.

Design/Detailing for Ductility for Structures

The site specific design acceleration spectra is a reduced spectra and has an in-built allowance for ductility. Structures shall be engineered and detailed in accordance with relevant Indian/International standards to achieve ductility.

SITE SPECIFIC SEISMIC PARAMETERS FOR DESIGN OF STRUCTURES AND EQUIPMENT

The various site specific seismic parameters for the project site shall be as follows:

1)	Peak ground horizontal acceleration (MCE)	: 0.41 g
2)	Multiplying factor to be applied to the site specific horizontal acceleration spectral coefficients (in units of gravity acceleration 'g') to obtain the design acceleration spectra	
a)	for ordinary moment resisting steel frames designed and detailed as per IS:800	: 0.103
b)	for braced steel frames designed and detailed as per IS:800	: 0.077
c)	For special moment resisting RC frames designed and detailed as per IS:456 and IS:13920	: 0.062
d)	for RCC chimney	: 0.205
e)	for liquid retaining tanks	: 0.123
f)	for steel chimney	: 0.154
g)	for design of structures not covered under 2 (a) to 2 (f) above and under 3 below	: 0.103
3)	Multiplying factor to be applied to the site specific horizontal acceleration spectral coefficients (in units of gravity acceleration 'g') for design of equipment and structures where inelastic action is not relevant or not permitted	: 0.205

Notes:
1. g = Acceleration due to gravity
2. For industrial structures, analysis for verification of mechanism shall be carried out as per IS:1893 (Part 4):2015

The horizontal seismic acceleration spectral coefficients are furnished in subsequent pages.

HORIZONTAL SEISMIC ACCELERATION SPECTRAL COEFFICIENTS
(In units of 'g')

Time Period (Sec)	Damping Factor (as a percentage of critical damping)		
	2%	3%	5%
0	1.000	1.000	1.000
0.03	1.000	1.000	1.000
0.04	1.555	1.405	1.293
0.05	2.190	1.828	1.578
0.06	2.898	2.267	1.857
0.07	3.670	2.720	2.131
0.075	3.670	3.175	2.267
0.08	3.670	3.175	2.500
0.083	3.670	3.175	2.500
0.085	3.670	3.175	2.500
0.09	3.670	3.175	2.500
0.1	3.670	3.175	2.500
0.105	3.670	3.175	2.500
0.11	3.670	3.175	2.500
0.115	3.670	3.175	2.500
0.12	3.670	3.175	2.500
0.125	3.670	3.175	2.500
0.13	3.670	3.175	2.500
0.135	3.670	3.175	2.500
0.14	3.670	3.175	2.500
0.145	3.670	3.175	2.500
0.15	3.670	3.175	2.500
0.2	3.670	3.175	2.500
0.22	3.670	3.175	2.500
0.23	3.670	3.175	2.500
0.24	3.670	3.175	2.500
0.3	3.670	3.175	2.500
0.35	3.670	3.175	2.500
0.4	3.670	3.175	2.500
0.45	3.111	2.822	2.222
0.5	2.800	2.540	2.000
0.55	2.545	2.309	1.818
0.6	2.333	2.117	1.667
0.65	2.154	1.954	1.538
0.7	2.000	1.814	1.429
0.75	1.867	1.693	1.333
0.8	1.750	1.588	1.250
0.85	1.647	1.494	1.176
0.9	1.556	1.411	1.111
0.95	1.474	1.337	1.053
1	1.400	1.270	1.000

HORIZONTAL SEISMIC ACCELERATION SPECTRAL COEFFICIENTS
(In units of 'g')

Time Period (Sec)	Damping Factor (as a percentage of critical damping)		
	2%	3%	5%
1.05	1.333	1.210	0.952
1.1	1.273	1.155	0.909
1.15	1.217	1.104	0.870
1.2	1.167	1.058	0.833
1.25	1.120	1.016	0.800
1.3	1.077	0.977	0.769
1.35	1.037	0.941	0.741
1.4	1.000	0.907	0.714
1.45	0.966	0.876	0.690
1.5	0.933	0.847	0.667
1.55	0.903	0.819	0.645
1.6	0.875	0.794	0.625
1.65	0.848	0.770	0.606
1.7	0.824	0.747	0.588
1.75	0.800	0.726	0.571
1.8	0.778	0.706	0.556
1.85	0.757	0.686	0.541
1.9	0.737	0.668	0.526
1.95	0.718	0.651	0.513
2	0.700	0.635	0.500
2.05	0.683	0.620	0.488
2.1	0.667	0.605	0.476
2.15	0.651	0.591	0.465
2.2	0.636	0.577	0.455
2.25	0.622	0.564	0.444
2.3	0.609	0.552	0.435
2.35	0.596	0.540	0.426
2.4	0.583	0.529	0.417
2.45	0.571	0.518	0.408
2.5	0.560	0.508	0.400
2.55	0.549	0.498	0.392
2.6	0.538	0.488	0.385
2.65	0.528	0.479	0.377
2.7	0.519	0.470	0.370
2.8	0.500	0.454	0.357
2.85	0.491	0.446	0.351
2.9	0.483	0.438	0.345
2.95	0.475	0.431	0.339
3	0.467	0.423	0.333
3.05	0.459	0.416	0.328
3.1	0.452	0.410	0.323
3.15	0.444	0.403	0.317

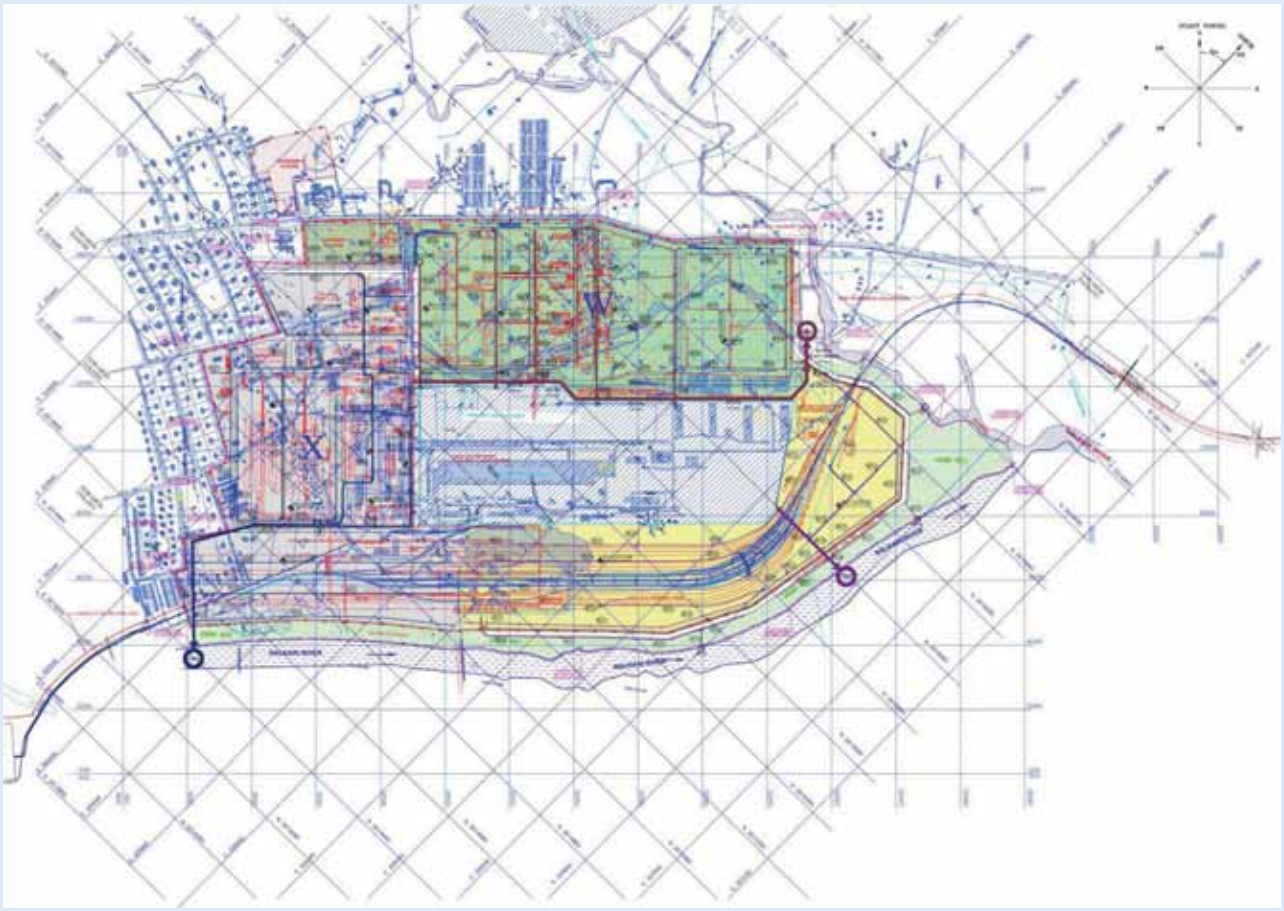
HORIZONTAL SEISMIC ACCELERATION SPECTRAL COEFFICIENTS
(In units of 'g')

Time Period (Sec)	Damping Factor (as a percentage of critical damping)		
	2%	3%	5%
3.2	0.438	0.397	0.313
3.25	0.431	0.391	0.308
3.3	0.424	0.385	0.303
3.35	0.418	0.379	0.299
3.4	0.412	0.374	0.294
3.45	0.406	0.368	0.290
3.5	0.400	0.363	0.286

Annexure-3

Area Drainage Study for Plant and Ash Dyke for Patratu STPP

Sponsor: NTPC Limited, Plot No.A-8A, Sector-24, Post Box No.13, Noida, U.P.



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May, 2017

IITR Project No. WRC/6003/16-17

Area Drainage Study for Plant and Ash Dyke for Patratu STPP

Final Report

May, 2017

Submitted to

NTPC Limited, Plot No.A-8A, Sector-24, Post Box No.13, Noida, U.P.

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EXECUTIVE SUMMARY

INTRODUCTION

Patratu Thermal Power Station (PTPS) was implemented with Russian collaboration in 1962. It is located near villages Hesla, Jaynagar, koto, Katia and Balkudra just outside the coal belt of South Karanpura in Ramgarh District of Jharkhand State, India. The plant initially had a power generation capacity of 840 MW which was derated to 770 MW. PTPS has six Russian units (Unit #1 to #6) which are 36 to 42 years old and four BHEL (India) manufactured units. Central Electricity Authority (CEA) of Government of India has recommended for immediate phasing out of Unit1, Unit 2, Unit 3, Unit 5 & Unit 8. CEA has also recommended for phasing out of Unit 4 & Unit 6 by 2017 and then phasing out of Unit 9 and Unit 10 in near future.

A Memorandum of Agreement (MOA) was entered on 03.05.2015 amongst Govt. of Jharkhand (GOJH), and NTPC Limited to form a Joint Venture (JV). The MoA was signed for transfer of Patratu Thermal Power Station (PTPS) to the proposed JV Company for performance improvement of existing capacity & for 4000 MW Capacity expansion of PTPS. The JV agreement was signed on 29.07.2015 and JV Company namely Patratu Vidyut Utpadan Nigam Limited (PVUNL) incorporated on 15.10.2015 with Ministry of Corporate affairs, Govt. of India. The 4000 MW capacity expansion is to be implemented in two phases; Phase-I: 3x800 MW and Phase-II: 2x800 MW. The present proposal is for implementation of Patratu Super Thermal Power Station Phase-I (3X800 MW).

NTPCL vide its letter No. 01/CS-0000-742A-9-PRA dated 02.08.2016 asked IIT Roorkee to submit offer for “Area Drainage Study for Plant and Ash Dyke for Patratu STPP (3x800 MW)”. Based on IIT Roorkee offer, NTPCL issued an LOA to IIT Roorkee vide letter no.01/CS-9585-742-9-CY-LOA-6508 dated 06.09.2016 stating therein the scope of area drainage study for Plant and Ash Dyke of Patratu STPP Phase-I. The scope of work is explained in chapter 1.

Field Visit and Review of Available Information

Site visit was conducted during 14.10.2016 to 15.10.2016 Reconnaissance survey of the topography, soils, existing land use, and natural drainage was carried out along with the staff of NTPC Ltd and discussions were held with project staff at site. Documents/Data have been

collected from various sources (list of documents given in chapter 1) and relevant information has been utilized in this study:

STUDY AREA CHARACTERISTICS

Location and Layout Plan of PSTPP Phase-I

The proposed site of PSTPP Phase-I is located near Patratu village in Ramgarh district of Jharkhand state. Proposed site is about 27 km from National Highway NH-75. State Highway SH-2 which is adjacent to plant boundary connects the plant with NH-75 and NH-33.

The layout of the proposed Stage-I (3X800MW) has been developed in the space available between the existing plant boundary wall and public road on North side of the plant (see figure in chapter 6). The total land to be transferred by the Government of Jharkhand/JUUNL to JV Company is 1859 acre. Out of 1859 acre, about 1234 acre of land has been envisaged for Patratu STPP, Phase-I (3X 800 MW) Plant, Ash pond and Railway Siding.

The main power house is along East-West direction. The proposed plant is envisaged with Air Cooled Condenser and space for the same is kept towards East side in between the plant and switchyard. Administration Building is proposed to be located outside the plant boundary near the main approach road. The main power house will be 420.5 M long and 41.0 M wide consisting of TG bay and heater bay.

Two ash dyke areas are available. Approx. 400 acre of land is available in Dyke -I. The land is located about 3 km from the plant boundary. The ash Dyke-II of about 300 acre is presently being used for disposal of ash from the existing units of Patratu Plant. It is also located about 3 km from the plant, but on the diametrically opposite side of Dyke -I.

Natural Drainage

The study area (within 10 km radius from main plant) lies in the upper Damodar valley. Drainage pattern is in west to east direction in northern and central part of study area whereas it is from south to north in southern part of study area. Sources of water for the proposed and future thermal power plants are the existing reservoir at Patratu and runoff in tributary sub catchments in upper Damodar valley. Upper Damodar River (also known as Deonad) is the main river in study area. Nalkari River is a right bank tributary of Upper Damodar River. Average annual rainfall in the catchment is 1270 mm. The Nalkari River attained the maximum flood level of

367.5 m near Patratu power plant site in the year 1958 i.e. prior to construction of the Nalkari dam.A dam has been constructed on Nalkari River near village Patratu during the period 1962-1968 and it is now more than 50 years old.

Natural Drainage in vicinity of Plant Area and Ash Dykes

Nalkari River: The existing Patratu power plant and the proposed plant lie in the adjacent to Nalkari river in downstream of the Nalkari dam.

Tilaiyatar nala : It passes through the ash dyke-II area. The Tilaiyatar nala joins Nalkari river on its left bank.

SY nala: Another nala passes through the proposed site of main plant area. It is named SY nala for the sake of discussion. SY nala joins theTilaiyatar nala coming from Ash dyke–II area.

Purnatoli nala: A nala passes through the ash dyke-I area. Ash Dyke-I area lies on the right bank side of Nalkari river. The Purnatoli nala joins Nalkari river on its right bank

Soil Type, Land Use /Land Cover

CIMFR (2015) have carried out soil analysis of samples from the sapling locations in upstream and downstream of of ash pond; six times in the year 2014 .The analysis shows that soil type is sandy loam.

Land use and land cover map was prepared using remote and GIS techniques. The area is mainly occupied by Dense Forest (28.54 %), Agriculture (23.41 %), Fallow land (19.80 %), Open Forest (13.84 %), Waste land (6.63 %), Settlement (4.06 %) and Waterbody (3.72 %).

Climate

The area lies in the sub-humid region of Chotanagpur Plateau and enjoys semi-extreme type of climate. The day temperature rises around 40 °C during the summers and drops down to around 10 °C during the winter. Three broad seasons can be recognized; the winter season(November to February); the hot season(March to May) and the rainy season(June to October).The average annual rainfall in Ramgarh district is 1251 mm More than 80% of the precipitation is received during the monsoon months.

DIGITAL ELEVATION MODEL STUDY

Digital elevation model (DEM) is the digital representation (digital map) of the ground elevation data in meters. The following data have been used for DEM study:

i) Contour map of the plant area with contour interval of 0.50 m. This map has been prepared using recent grid survey data of the plant area.

ii) Geographic referencing points: These have been extracted from the features common in the toposheet and the map based on recent topographic survey and georeference points provided by M/S NTPC Limited.

iii) Survey of India Toposheet (1: 50000 scale): Toposheet Number 73 E/2 and 73 E/6 of year 1978-79.

iv) Plant layout map showing location and ground formation levels of various components of the Patratu Super Thermal Power Project (STPP)

DEM of the plant area: North part of the plant area has lowest elevation of 357.5 m whereas the South West part has highest elevation of 388.9 m. . The central part of the plant area has an elevation of 380.5 meter. The North West part of the study area has elevation in the range of 366.0 m to 375.0 m. North Eastern part of the study area has an elevation of 376 m to 380 m.

DEM of the ash pond area 2: The north eastern part of the Ash pond area has lowest elevation of 376 m. The North western part of the study area has highest elevation of 388 m.

DEM of the ash pond 1: The variation in elevation is from 356 m to 391 m in the ash pond 1 area. North-eastern part of the Ash pond area has lowest elevation of 356.0 m. The south-eastern part of the ash pond area has highest elevation of 391 m.

DEM of the Green belt area: Southern part of the Green belt area has highest elevation of 374 m. The Northern part of the study area has lowest elevation of 350 m.

DEM of the colony area: North eastern part of the colony area has lowest elevation of 372 m. The South western part of the study area has highest elevation of 395 m.

Generation of Stream Network: The Spatial analyst tools of ARC-GIS software has been used for generation of stream network.Drainage network created from DEM was overlaid with the

topo sheet drainage network. It is seen that major drainage of the study area is matching with the drainage created from DEM. Drainage of the area has not much changed over the time period.

Distribution of Land Area at Different Elevation: The Digital Elevation Model prepared in ARC-GIS has been used to compute the land area between different elevation ranges separately for plant area, ash pond-I, ash pond-II, colony area, and green belt area. This information in tabular and graph form(details in chapter 3)will provide a guideline for fixing FGL and for deciding volume of cut and fill earth work in each of the component area.

DESIGN STORM SCENARIOS

Design storm and flood scenarios are required for (i) planning of drainage in the plant area and vicinity and (ii) for assessing possible submergence in the plant area from internal and external flooding.

Frequency Analysis of 1-Day Annual Maximum Rainfall at Ranchi: Daily rainfall data are available at Ranchi from 1971 to 2011 (41 years). 1-Day annual maximum rainfall series was constructed and EV Type I probability distribution was applied to estimate 1-day and converted 24 hour rainfall of 25 year,50 year and 100 year return period .

Regional Depth Duration Frequency Studies: The study area lies in Lower Ganga Plains Sub Zone defined by Central Water Commission (CWC 1994). India Meteorological Department (IMD) has conducted detailed rainfall study for this Sub Zone (CWC 1994) utilizing the data of 49 self-recording rain gauge stations and 173 ordinary rain gauge stations The Upper Damodar Valley area covered by the subzone provides well distributed SRRG data of 26 stations in 4 districts of Bihar (now Jharkhand).The CWC report provides Isopluvial maps of 25 year,50 year and 100 year return periods .

Recommendation: The 24 hour rainfall of 25 year(177 mm),50 year(201mm) and 100 year return period (232 mm) as per frequency analysis of 41years data at Ranchi and those as per isopluvial map are similar . It is recommended that the 24 hour storm rainfall values obtained from frequency analysis of 41 years rainfall data at Ranchi be used in further analysis as the station is close to the study area and data of recent period (1971 to 2011) and of sufficient length (41 years) have been used in the frequency analysis.

POSSIBILITY OF EXTERNAL FLOODING

Flooding due to flood in Nalkari river: Nalkari (a southern tributary of Upper Damodar river) is the major stream in vicinity of the power plant. The Nalkari river attained the maximum flood level of 367.5 m near Patratu power plant site in the year 1958 prior to construction of the Nalkari dam. The dam was constructed during the period 1962-1968. Flow in the Nalkari river in downstream of dam is controlled by operation schedule of the Nalkari reservoir. The Patratu reservoir has helped in significant reduction in flood water level in the downstream of the dam. Thus flood levels in vicinity of power plant are expected to be much lower than the maximum flood level which occurred in the year 1958 prior to construction of the Nalkari dam. The proposed FGL in plant area and town ship vary from372.0 m (in space for switch yard) to 382.0 m in township area which are much higher than the maximum flood level of 367.5 m prior to construction of the Nalkari dam.

The natural ground level in ash pond -II varies from 376.26 to 388.26. These elevations are much higher than the flood level in the natural streams in vicinity. Figure 5.3(chapter 5) shows the flood level of 367.5 m at different locations in area around plant site. Flooding can occur in vicinity of plant area only in case of dam breach for which a separate dam break study may be carried out.

Due to siltation in reservoir, effectiveness of reservoir (over a long period) in flood moderation could decrease. The dam is now 50 year old. In an earlier study by IIT Roorkee, capacity survey of Nalkari reservoir was carried out using remote sensing data. The capacity survey was carried out for the period 2006 to 2012 for the zone of reservoir level fluctuation between 387.096 m to 406.152 m. The original live storage capacity of 110.73 MCM reduced to 89.96 MCM (i.e. by 11.76 %) over the period of 44 years from 1968 (the year of construction) till the year 2012.

Flooding in Plant Area Due to SY Nala

This nala passes through the proposed site of main plant area. It joins the Tilaiyatar nala coming from Ash dyke–II area. The SY nala is proposed to be diverted and realigned in west- east direction between the existing switch yard and proposed main plant area.In the present study, 100 year flood in the SY nala has been estimated to assess possibility of flooding under existing conditions in the vicinity of the SY nala.

Flood in SY nala has been estimated using i) Rational Formula and ii) Regional Flood Frequency Model of CWC (1994). It is found that the estimated floods are of similar magnitude. It is recommended to use flood estimate using Rational formula as catchment size is very small for which rational formula is more appropriate as recommended by Central Water Commission (CWC 1994) and by *Research, Design &Standards Organization (RDSO) of Indian Railway, Government of India* (Report RBF 16).

In order to assess the flooding, bankful discharge capacity of SY nala has been estimated using slope area method. For estimation of cross section parameters, approximate ground levels on the left and right banks have been worked out with the help of recent contour map of the plant area. The bankful discharge of capacity of SY nala is significantly higher than estimated 100 year flood in this nala . Hence it is safe to conclude that flooding doesn't occur under pre project condition. During the field survey of the plant area villagers stated that flooding has never occurred in the area.

External Flooding in Post Project Condition

Existing land use, land cover and topography in the project area will get modified during post project condition. However, the net effect of changes in land use, land cover and topography in post project condition shall be negligible. The flood generated by storm rainfall is expected to be similar as for pre project condition as explained in chapter 5.

Realignment of SY Nala: The SY nala is proposed to be diverted and realigned in west- east direction between the existing switch yard and proposed main plant area. Layout and design channel capacity of the realigned Gangai nala are discussed in chapter 6.

Bank Protection For Existing Drains: Carrying capacity of a) Nalkari river (in the reach along the project boundary), b)entire length of realigned SY nala, c) Tilaiyatar nala in downstream of ash dyke-II and d) Purnatoli nala in downstream of ash dyke-I shall have to be maintained so that flood discharge is carried safely . No encroachment should be allowed in the flood plain of these drains.

INTERNAL DRAINAGE AND REALIGNMENT OF SY NALA

The plant components have been located on different ground formation levels by NTPC to economize the cost of earth work. The proposed formation levels are 372 m, 377 m, 378 m and

382 m. The DEM (chapter 3) can be used to identify areas requiring cutting and filling and to estimate the volume of earthworks required to level the undulating topography of the study area. Due consideration has been given to the existing slope of project area towards south and towards east in deciding the layout of internal drainage.

Three outfalls (OF1,OF2,OF3,) are envisaged for drainage of township, plant area and rail track area .Accordingly, the area is partitioned into three zones such that storm runoff from each of the zone is carried separately to the Purnatoli nala (through realigned SY nala) and to Nalkari river . Figure 6.2 and Table 6.2 show the partition of project area into W, X, Y, zones and drainage plan showing plant area drains.

W Zone: It includes switch yard, main plant area and any vacant land between Patratu – Ranchi road and the realigned SY nala,.The storm runoff shall be carried by realigned SY nala which has Outlet OF1 on end channel of original SY nala just upstream of confluence with Tilaiyatar nala.

X Zone: It includes Township-I area, Administration building area, WTP area, workshop, ZLD for FGD, temp gypsum storage, crushed coal stock pile area, wind barrier for coal stock yard, part of rail track and other area occupied by misc facilities. Internal drainage for township area will depend on layout plan of the township. Location of Outlet OF2 for zone X will be on Nalkari river. Depending on whether combined or separate sewage and sewerage system are planned, the storm runoff from coal yard area can be separated and storm runoff is carried to another outfall adjacent to OF2.

Y Zone: It mainly includes Railway track area and open land between a)existing main plant upto Nalkari river bank and b)open land on east side between existing plant and boundary of proposed plant . Outfall (OF3) for this zone is located on Nalkari river. W zone also includes 12 m wide ash silo approach road which is located along the green belt. Storm water runoff from this road and adjoining area can be separately drained into Nalkari river at outfalls OF3a, OF3b and OF3c.

As per NTPC norms, internal drains are to be designed to safely carry 25 year flood so as to economize the cost of construction, maintenance and cost of land which shall be occupied by the drains. The 25 year flood estimate in SY nala has been explained in chapter 5. The 25 year flood estimate in SY nala is 11.7 cumec and discharge per unit area is 0.152 cumec/ha.

Carrying Capacity and Size of Channel Segments

It is not necessary that a long drain should have same discharge carrying capacity throughout its length to carry the entire discharge generated from its catchment. In order to economize the cost and land area occupied by drains, a suitable number of channel segments may be considered. An unit length of approximately 200 m has been considered for a channel segment and its own contributing catchment is taken to be about 4 hectare (200mx200m).Discharge contributed by catchment of a channel segment is added to the capacity of its upstream channel segment(s) to estimate carrying capacity of the particular channel segment. Layout and carrying capacity of drains in zone W, X, and Y have been worked out. Size of different channel segments in zone W, X, and Y are stated in table 6.4, table 6.5 and table 6.6 respectively. Figure 6.3, Figure 6.4 and Figure 6.5show layout of channel segments in zone W,X,Y respectively. **Carrying capacity of different channel segments of the Realigned SY nala (RSYN) are stated in table 6.4. It is master drainage channel of W zone .It is designed to carry storm runoff from W zone and from existing plant area.**

6.3.2 Channel Sections for Internal Drainage and Realigned SY Nala

Internal drainage channels as well as the realigned SY nala (RSYN) are designed as rectangular open channel to take discharge from assigned drainage areas. Manning's roughness coefficient is taken for concrete channel (0.016). Width of drains shall not be less than 0.75 m considering cleaning by mechanical means.

Bed Slope: Internal drainage channels in W,X,Y zones will have bed slope of 1:1000 i.e.1m/km or 0.001.However, the last two channels(end channel and preceding channel) in each zone will be laid at 1;500 slope(s=0.002) as sufficient natural gradient is available. This will reduce size and hence capital cost of drain.

The realigned SY nala (RSYN) is considered as master drain of W zone. It will carry runoff from W zone and also from existing plant area.It is proposed to lay the realigned SY nala on a slope of 1:500(i.e.1m/500 m or 0.002) having rectangular concrete section. Cross section of RSYN is increased in steps to accommodate flow contribution from various parts of W zone and existing plant.

Vertical Falls on Channels

Plant components in W zone are at different FGL (382 m, 377 m, and 372 m). Similarly plant components in X zone are at different FGL (378 m and 372 m). Therefore, vertical falls are necessary to negotiate difference in bed level of connecting channels. Well type fall (also called cylinder fall) is suitable and economical for large height fall and small discharge. For low height fall and large discharge, crest weir over full width of channel is suitable. Location of vertical falls in W zone and X zone are shown in figure 6.3 and 6.4 respectively. Location and size of vertical falls in W zone and X zone are given in table 6.7 and table 6.8 respectively.

CHAPTER 1

INTRODUCTION

1.1 PROJECT BACKGROUND

The National Thermal Power Corporation Limited (NTPC) is largest power generating corporation in India. Although the corporation has 17.73% of the total national capacity, it contributes 25.91% of total power generation with focus on high efficiency. Presently, it has total installed capacity of 45,548 MW (including Joint Ventures) and has an ambitious growth plan of becoming a 1, 28,000 MW Corporation by the year 2032. NTPC has adopted a multi-pronged growth strategy which includes capacity addition through green field projects, expansion of existing stations, joint ventures, subsidiaries, and take-over of stations. The company was rechristened as NTPC Limited on October 28, 2005. Furthermore, it was conferred with "MAHARATNA" status by the Government of India on 21.05.2010.

A Memorandum of Agreement (MOA) was entered on 03.05.2015 amongst Govt. of Jharkhand (GOJH), Jharkhand Urja Vikash Nigam Limited (JUVNL), Jharkhand Urja Utpadan Nigam Limited (JUUNL), Jharkhand Bijli Vitaran Nigam Limited (JBVNL) and NTPC Limited to form a Joint Venture (JV) Company of NTPC Limited & JBVNL(with 74:26 equity participation).The MOA was for transfer of existing Patratu Thermal Power Station (PTPS) (located in Tamgarh district of Jharkhand state) to the proposed JV Company for performance improvement of existing capacity & 4000 MW Capacity expansion of PTPS. The JV agreement was signed on 29.07.2015 and JV Company namely Patratu Vidyut Utpadan Nigam Limited (PVUNL) incorporated on 15.10.2015 with Ministry of Corporate affairs, Govt. of India.

The existing Patratu Thermal Power Station (PTPS) is located near village Patratu in Ramgarh District of Jharkhand State. The PTPS was implemented with Russian collaboration in 1962. The plant initially had a power generation capacity of 840MW (unit #1 to #4: 50 MW +unit #5 & #6: 100 MW + unit #7 &#8: 110 MW +unit #9 &#10: 110 MW) derated to 770 MW (unit #1 to #4: 40 MW +unit #5 & #6: 90 MW + unit #7 &Unit #8: 105 MW + unit #9 &Unit #10: 110 MW).PTPS has six Russian units (Unit #1 to #6) of 36 to 42 years old and four BHEL manufactured units. CEA has recommended for immediate phasing out of Unit #1, 2, 3, 5 & 8. CEA has also recommended for phasing out of Unit #4 & 6 by 2017 and phasing out of Unit #9 and 10 by 14th Plan.

The capacity expansion of 4000 MW is to be implemented in two phases; Phase I: 3x800 MW and Phase II: 2x800 MW. The present proposal is for implementation of Patratu Super Thermal Power Station Phase-I (3X800 MW) capacity.

NTPCL vide its letter No. 01/CS-0000-742A-9-PRA dated 02.08.2016 requested IIT Roorkee to submit offer for "Area Drainage Study for Plant and Ash Dyke for Patratu STPP (3x800 MW)". Based on IIT Roorkee offer no. WR/AP/905 dated 05.08.2016, NTPCL issued an LOA to IIT Roorkee vide letter no.01/CS-9585-742-9-CY-LOA-6508 dated 06.09.2016 stating therein the scope of work and the terms and conditions acceptable to IIT Roorkee. Dean of Sponsored Research and Industrial Consultancy (SRIC) of IIT Roorkee approved this consultancy work as per norms of IIT Roorkee.

1.2 SCOPE OF WORK

The scope of work assigned to IIT Roorkee is as follows:

A. Survey Work and Area Drainage

1. Study of existing natural drainage pattern/system, available information in the form of reports, literature, satellite imageries, etc. having a bearing on the storm water drainage system of proposed plant and ash dyke areas of the project and its adjoining areas. The study shall include review of topographical features of the proposed site and its surrounding areas.
2. Review and analysis of rainfall information to arrive at design storm scenarios.
3. Review and analysis of relevant Survey of India Topographical Sheets, topographical survey and satellite imageries.
4. Estimation of flood hydrographs considering historical as well as design rainfall to suggest complete scheme for storm water drainage of site and its adjoining area including diversion of nallas/streams, if any.
5. Estimation and routing of design flood hydrograph through the drainage system of concerned catchments considering appropriate boundary conditions including pre-construction scenario as well as post-construction scenario for suggesting remedial measures for the site
6. Suggesting final disposal point for the storm water from site and size of the disposal drain
7. Site visit for acquaintance of prevailing conditions and collection of available data at site.
8. Visit to NTPC corporate Engineering office for discussions regarding the study.

1.3 FIELD VISIT AND REVIEW OF AVAILABLE INFORMATION

Site visit was conducted during 14.10.2016 to 15.10.2016 Reconnaissance survey of the topography, soils, existing land use, and natural drainage was carried out along with the staff of NTPC Ltd.

Documents/Data given below have been collected and relevant information has been utilized in this study:

1. Daily rainfall data for IMD station at Ranchi
2. IIT Roorkee(2013): Report (March 2013)on Water Availability Study of Patratu Reservoir and Related Thermal Power Plants prepared for PFC Consulting Ltd New Delhi.
3. IIT Roorkee(2010): Report(October,2010) on Identification of Water Source For Power Plant Linked to Mourya Coal Block (Jharkhand) prepared for PFC Consulting Ltd New Delhi
4. CGWB(2013): Ground Water Information Booklet of Ramgarh District, Jharkhand State by Central Ground water Board(Ministry of Water Resources,Govt. of India)(September,2013)
5. Natural drainage within proposed plant area and vicinity based on reconnaissance survey of the area.
6. NTPC Feasibility Report of Patratu Thermal Power Station Expansion-Stage I(DOC. No.:9585-999-NOG-J-001 R '0')
7. MoEF and CC: ToR for Patratu Super Thermal Power Project Phase I(3x800 MW) issued vide letter dated 7.6.2016
8. CIMFR(March,2015):Report on Evaluation of Different Environment Parameters at PTPS(Jan2014-Dec 2014) by Central Institute of Mining and Fuel Research, Dhanbad
9. CWC (2001): Manual on Estimation of Design Flood, Central Water Commission, Government of India,New Delhi .
10. CWC(1994): Flood Estimation Report for Lower Ganga Plains Subzone-1(g), Central Wat6er Commission, Government of India, New Delhi
11. RDSO:Report No RBF-16 'Flood Estimation Methods for Catchments Less Than 25 Km2 in Area' prepared by Research, Design &Standards Organization(RDSO) of Indian Railway, Government of India

CHAPTER 2

THE STUDY AREA CHARACTERISTICS

2.1 PHYSICAL ENVIRONMENTAL SETTING OF THE SITE

The proposed site of PSTPP Phase-I is located near Patratu village in Ramgarh district of Jharkhand state. It is adjacent to the existing Patratu thermal power plant. Environmental setting of the proposed plant site is given in table 2.1.Figure 2.1 is the index map of the proposed plant.

Area vicinity map within 10 km radius is given in Figure 2.2.

Table 2.1: Physical Environmental Setting of Proposed Plant Site

Sl. No.	Particulars	Details
1	Plant location	Near Patratu village in Ramgarh district of Jharkhand state in India
2	Toposheet Nos.	Survey of India Toposheet number 73E/6 on 1:50000 scale.
3	Site Coordinates	Latitude 23°37'30"N and Longitude 85°16'25"E
4	Plant site elevation above MSL	405 m above msl
5	Road Connectivity	Proposed site is about 27 km from National Highway NH-75. State Highway SH-2 which is adjacent to plant boundary connects the plant with NH-75 and NH-33.
6	Nearest railway station	Patratu about 5.5 km
7	Nearest Airport	Birsa Munda Airport Ranchi about 50 km
8	Nearest major water bodies	Nalkari reservoir on Nalkari river
9	Nearest village	Patratu
10	Nearest town/City	Ramgarh about 35 km
11	Reserved (RF) / Protected Forests	None
12	Source of water	Patratu reservoir (Nalkari Dam)

The total land to be transferred by the Government of Jharkhand/JUUNL to JV Company is 1859 acre. Out of 1859 acre, about 1234 acre of land has been envisaged for Patratu STPP, Phase-I (3X 800 MW) Plant, Ash pond and Railway Siding.

2.2 GENERAL LAYOUT PLAN

General Layout Plan (GLP) for the project is given in chapter 6. The layout of the proposed Stage-I (3 × 800MW) has been developed in the space available between the existing plant boundary wall and public road on North side of the plant. Some of the existing structures in the proposed area shall need to be dismantled. The public road may also require diversion in some stretches depending upon the availability of space for the proposed facilities.

The switchyard orientation has been planned towards East side of the main plant block taking into consideration the requirement of power evacuation. The main power house is along East-West direction, with permanent facilities like Workshop, Permanent stores etc., located close to the main plant. The Chimney is towards West of main plant. The ash slurry/ash water pump house is kept towards near chimney. Space provision for FGD has been kept towards West of main plant beyond chimney.

The proposed plant is envisaged with Air Cooled Condenser and space for the same is kept towards East side in between the plant and switchyard. The water treatment plant and the DM water facilities are located close to main plant. The coal handling plant and the coal stockyard are located towards South-West of the main plant considering the railway siding from South side.

Administration Building is proposed to be located outside the plant boundary near the main approach road. The main plant building arrangement for the proposed stage -I of the plant envisages longitudinal disposition of TG set. The main power house will be 420.5 M long and 41.0 M wide consisting of TG bay and heater bay.

2.3 ASH DISPOSAL AREA

Two ash dyke areas are available. At one place approx. 400 acre of land is available (Dyke #1). The land is located about 3km from the plant boundary. The second area (Dyke #2) of about 300acre is presently being used for disposal of ash from the existing units of Patratu Plant. It is also located about 3km from the plant, but on the diametrically opposite side of Dyke #1.

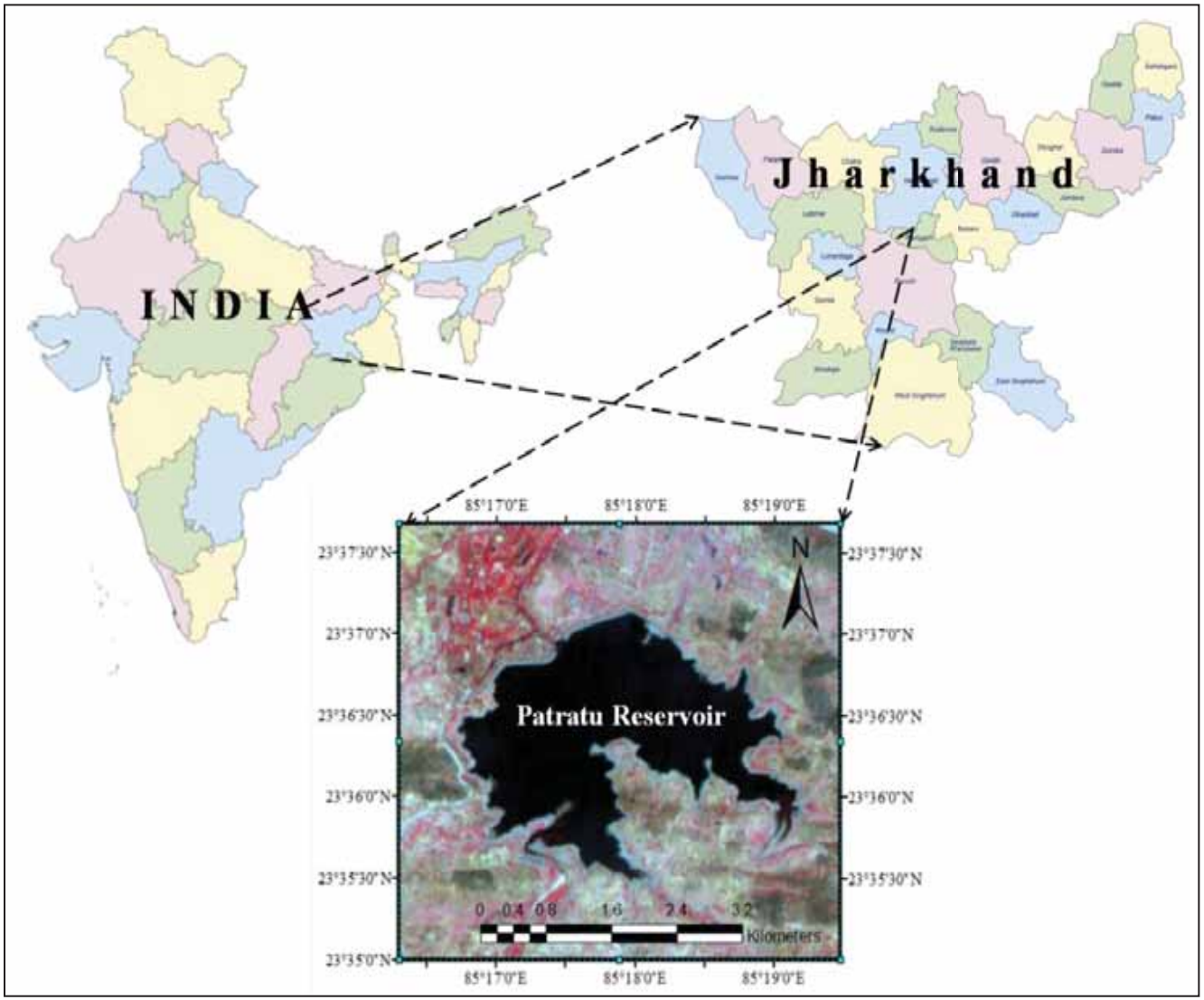


Figure 2.1: Index map of Patratu plant site and reservoir

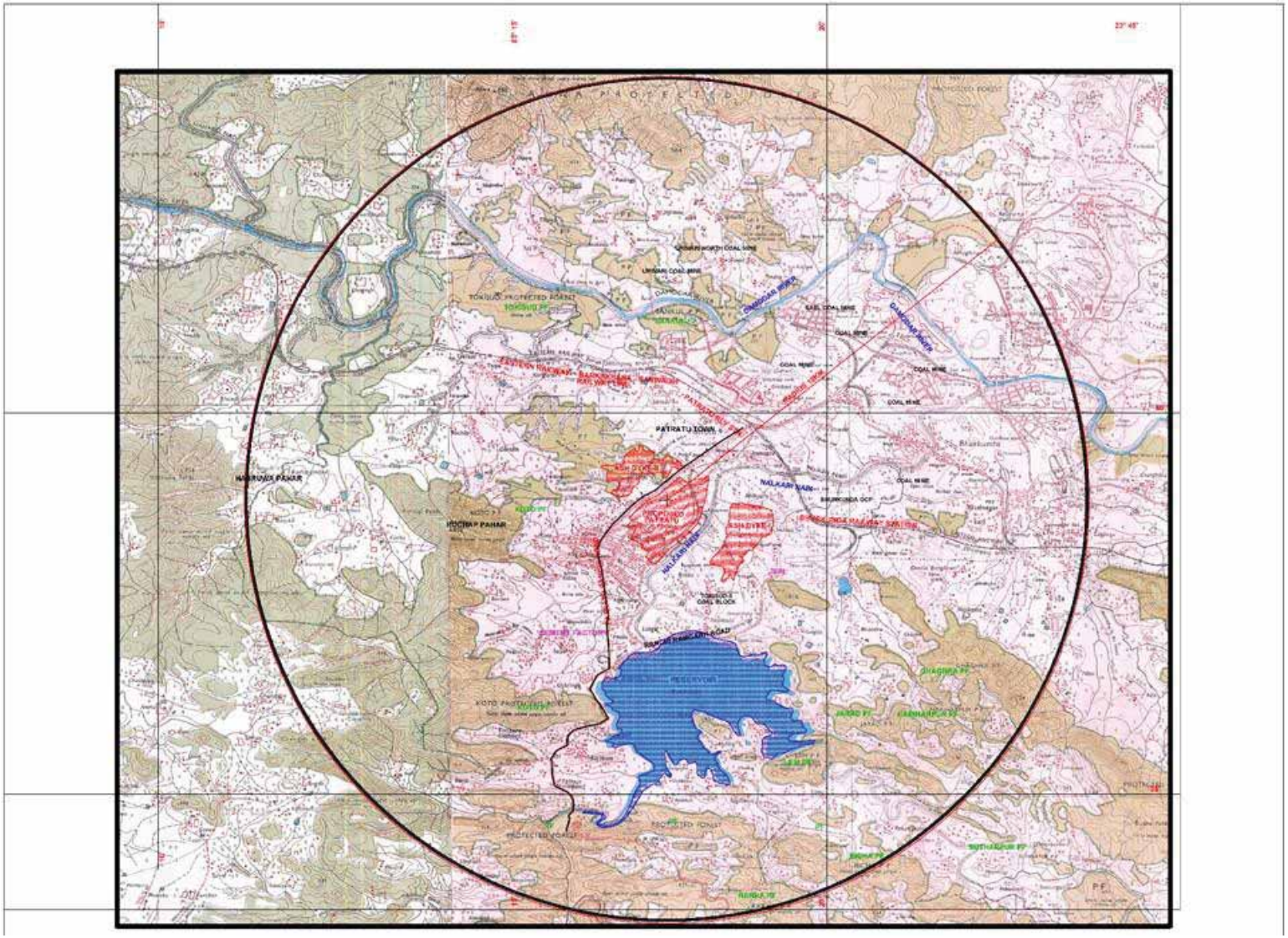


Figure 2.2: Vicinity map of the Study area (10 km radius)

Presently, ash is being disposed in the form of lean slurry. As per MOEF guideline, 600acre of land is required for disposal of ash from Patratu STPP, Phase-I, 2400 MW (3X800MW) i.e. @

0.25 acre/MW. The undulations of ground levels on Dyke #1land may be of the order of 5-10m. A dyke embankment exists and average height of this embankment is about 4-5m.

Fly Ash (FA) from new units of Patratu STPP, Phase-I (3X800MW) is proposed to be disposed off through High Concentration Slurry Disposal (HCSD) system and bottom ash (BA) in the form of lean slurry.Considering the availability of two existing ash dyke areas at two different locations, it is envisaged to utilize Dyke #1 (about 400 acre) area for FA disposal and Dyke #2 (about 300acre) for BA disposal.

For developing 11.51 million cu.m (9.21 million cu.m FA & 2.30 million cu.m BA) of storage capacity, two storage lagoons for Fly Ash disposal by High Concentration Slurry Disposal (HCSD) system at Dyke #1 & two storage lagoons for disposal of bottom ash by wet slurry disposal system at Dyke #2 with one overflow lagoon at each location for storing decanted water from above storage lagoons will be constructed. For developing 9.21million cu.m capacity at Dyke #1, average 6m and 8m high embankments are envisaged and will be constructed on existing ground along the periphery of the HCSD area. Existing Dyke #2 is presently being used for slurry disposal from existing units and is almost exhausted.

For BA disposal from new units, it is envisaged to use existing Dyke #1 by strengthening and 3 future raisings of 3m height each to cater to BA disposal as per norms. However, extent and type of strengthening shall be decided after getting detailed topographic survey and geotechnical investigation report which are under progress.

2.4 TOPOGRAPHY

Area within 10 Km Radius: Figure 2.3 shows the topography of the study area within ten Km radius. Elevation varies from 286 m in eastern part to 723 m in southern, south west and northern parts.

Plant Area: North part of the plant area has lowest elevation of 357.5 m whereas the South West part of the plant area has highest elevation of 388.9 m. The centre part of the plant area has an elevation of 380.5 meter. The North West part of the plant area has elevation in the range of 366.0 m 375.0 m. North Eastern part of the plant area has an elevation of 376 m to 380 m. These

elevations will provide a guideline for economizing the cost of earth work during the design of plant.

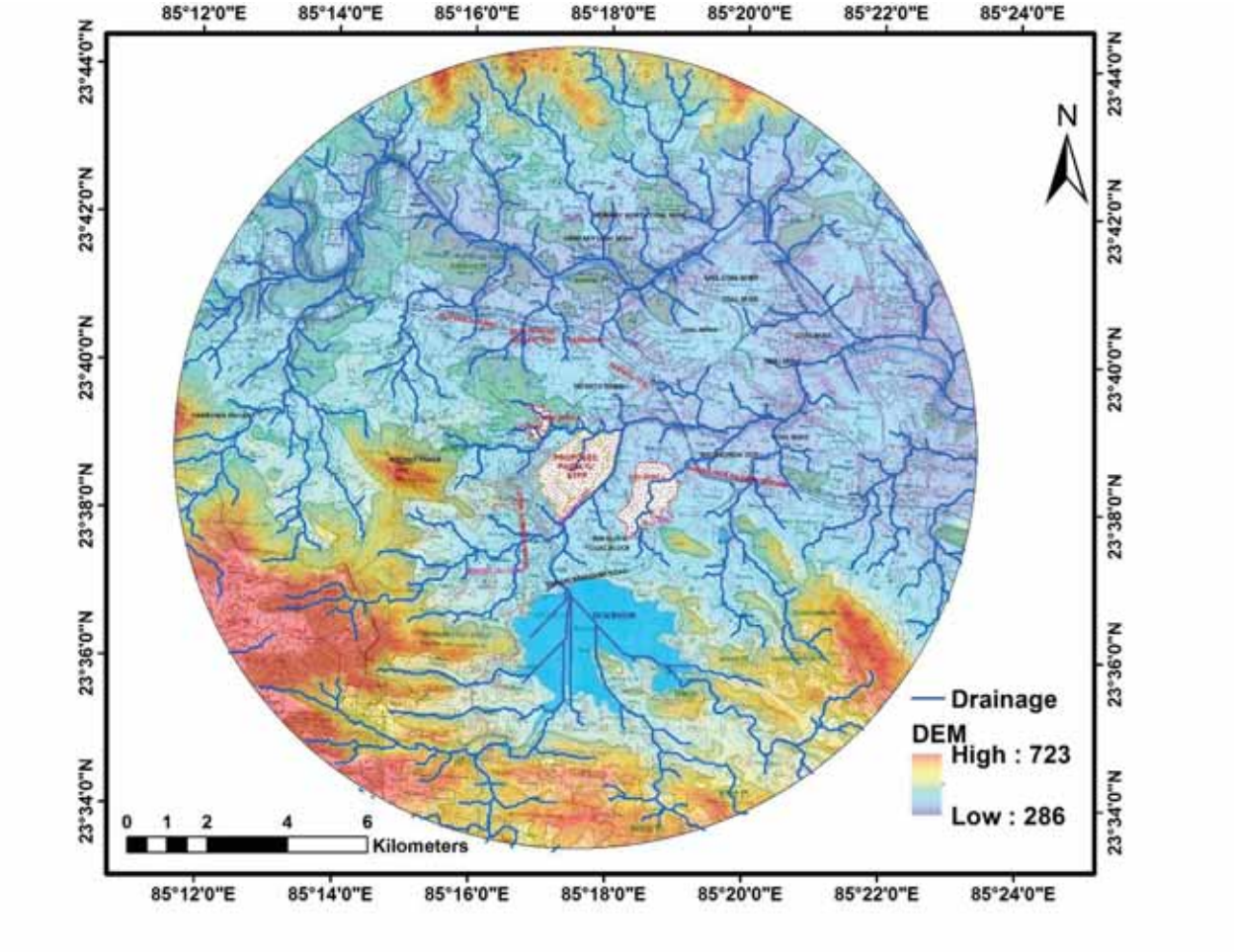


Figure 2.3: Topography and natural drainage in the study area within ten Km radius

2.5 NATURAL DRAINAGE

Figure 2.3 shows the natural drainage in study area within ten Km radius. The study area lies in the upper Damodar valley. Sources of water for the proposed and future thermal power plants are the existing reservoir at Patratu and runoff in tributary sub catchments in upper Damodar valley. Drainage pattern is in west to east direction in northern and central part of study area whereas it from south to north in southern part of study area.

Upper Damodar River is the main river in study area. The River Damodar originates near Rajruppa from the lava capped Khamarpat hill in Palamau district. In upper reaches it is known as Deonad. Traversing through the steep slopes of the hilly region, it descends on the flat plain of Chandwa basin. After the confluence with Dharamauti, the Damodar enters the Gondwana basin

and the landscape changes. The gradient of the stream becomes steeper and waterfalls abound the course of the stream. The river receives a number of tributaries in this section both from southern and northern slopes. The southern tributaries originating from Ranchi plateau are the Chati, the Dainkata, the Saphi (414 km^2), the Batuka, the Nalkari and the Dhobdhab. The northern tributaries originating from Hazaribagh plateau are the Ramghat – Haharo (570 km^2), the Marmahar (130 km^2), the Konar (1295 km^2), and the Bokaro (595 km^2).

Nalkari River is a right bank tributary of Upper Damodar river. Average annual rainfall in the catchment is 1270 mm. The Nalkari river attained the maximum flood level of 367.5 m near Patratu power plant site in the year 1958 i.e. prior to construction of the Nalkari dam.

The Nalkari Reservoir: A dam has been constructed on Nalkari River near village Patratu in Ramgarh District. Figure 2.4 schematically depicts the size of Nalkari dam and the reservoir. The dam was constructed during the period 1962-1968 and it is now more than 50 years old. Catchment area of the reservoir is 212.38 sq. km (81.32 sq miles).The reservoir is located between Latitude $23^0$36'13''N to $23^0$36'18''N and Longitude $85^0$16'50''N to 85018'54''N. Earthen non overflow section (on right and left flank) of the dam is 10376 ft long and masonry overflow section (spillway) is 320 ft long. The Nalkari reservoir is near to the Mourya coal field (13.87 km), railway line (4.62 km) and National Highway 23 (22.73 km). Gegde is the nearest village (2.98 km).

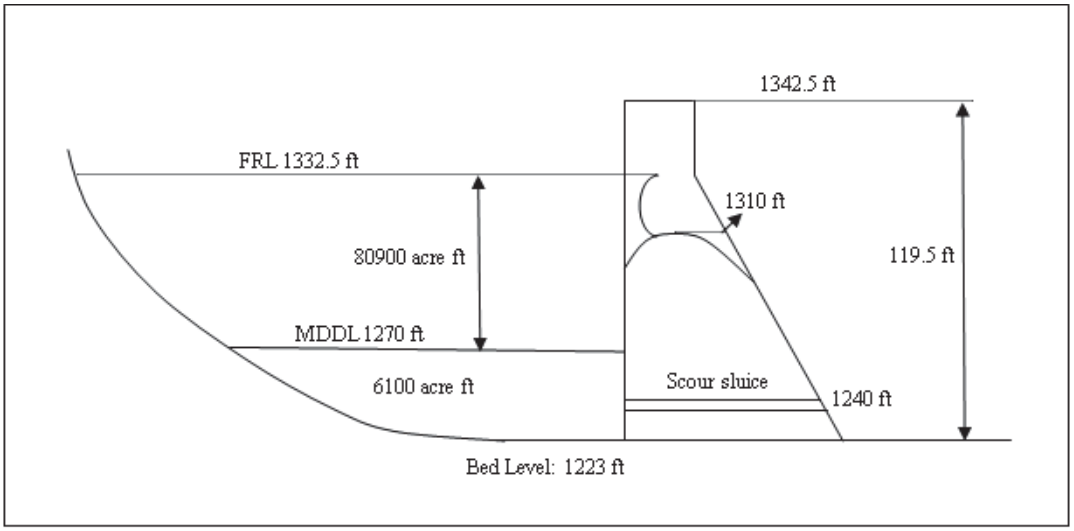


Figure 2.4: Size of the Nalkari dam and reservoir

Natural Drainage in vicinity of Plant Area and Ash Dykes

Nalkari River: The existing Patratu power plant and the proposed plant lie in the adjacent to Nalkari river in downstream of the Nalkari reservoir

Tilaiyatar nala : It passes through the ash dyke-II area. The Tilaiyatar nala joins Nalkari river on its left bank.

SY nala: Another nala passes through the proposed site of main plant area. It is named SY nala for the sake of discussion. SY nala joins the Tilaiyatar nala coming from Ash dyke–II area.

Purnatoli nala: A nala passes through the ash dyke-I area. Ash Dyke-I area lies on the right bank side of Nalkari river. The Purnatoli nala joins Nalkari river on its right bank

2.6 SOIL TYPE

CIMFR (2015) have carried out soil analysis of samples from the sapling locations in upstream and downstream of ash pond. The sampling and soil testing were carried out six times in the year 2014(in the months of February, April, June, August, October and December, 2014. The analysis shows that soil type is sandy loam. Soil parameters are given in table 2.2.

Table 2.2: Soil Parameters

PARAMETER	SOIL IN U/S AREA	SOIL IN D/S AREA
SAND (%)	58-66.2	51.2-59.1
SILT (%)	14.8-19.8	17.8-21.8
CLAY (%)	13.5-17.2	12.8-18.1
BULK DENSITY (%)	1.25-1.66	1.27-1.83
MOISTURE CONTENT (%)	2.3-3.6	2.9-4.2
WATER HOLDING CAPACITY (%)	20.6-23.18	22.14-24.17

2.7 LAND USE /LAND COVER MAP

Land use and land cover map was prepared using remote and GIS techniques. For this purpose, cloud free Landsat 8 OLI geocoded imageries of 19th December 2015 having eleven spectral bands were collected from USGS earth explorer. The satellite image was classified using supervised classification with maximum likelihood classification algorithm by visual

interpretation in ERDAS IMAGINE Software, which along with ARC GIS was used for generation of land use/land cover map. The spatial distribution of land use and land cover analysis for the area is provided in table 2.3. Figure 2.5 shows the land use land cover in study area. The area is mainly occupied by Dense Forest (28.54 %), Agriculture (23.41 %), Fallow land (19.80 %), Open Forest (13.84 %), Waste land (6.63 %), Settlement (4.06 %) and Water body (3.72 %).

Table 2.3: Areas under different land use/ land cover classes

Sl. No.	LULC	No. of Pixels	Area(ha)	Area (%)
1	Dense Forest	99630	8966.7	28.54
2	Waterbody	12991	1169.19	3.72
3	Agriculture	81701	7353.09	23.41
4	Open Forest	48301	4347.09	13.84
5	Waste Land	23145	2083.05	6.63
6	Settlement	14179	1276.11	4.06
7	Fallow Land	69124	6221.16	19.80
Total			**31416.39**	**100**

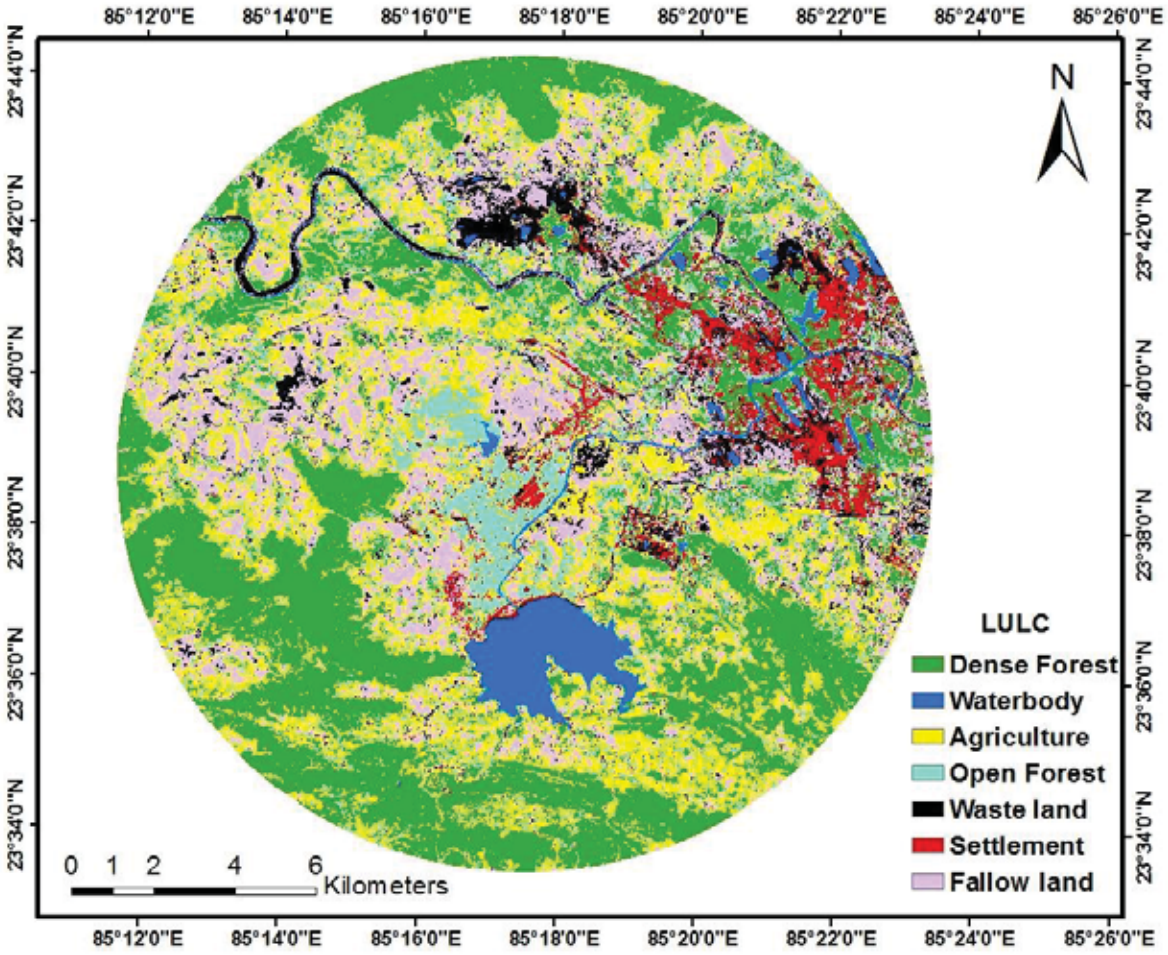


Figure 2.5: Land use / Land cover map of study area

2.8 CLIMATE

The area lies in the sub-humid region of Chotanagpur Plateau and enjoys semi-extreme type of climate. The day temperature rises around 40 °C during the summers and drops down to around 10 °C during the winter. Three broad seasons can be recognized; the winter season(November to February); the hot season(March to May) and the rainy season(June to October).The average annual rainfall in Ramgarh district is 1251.2 mm More than 80% of the precipitation is received during the monsoon months.

CHAPTER 3

DIGITAL ELEVATION MODEL STUDY

3.1 INTRODUCTION

Digital elevation model (DEM) is the digital representation (digital map) of the ground elevation data in meters. This digital map, a type of Digital Terrain Model (DTM) is raster data that it is made up of equally sized grid cells each with a unique elevation.

The projection and datum for a DEM may vary. In the present study, Polyconic coordinates (meters) have been used for geo-referencing of all maps. The following data have been used for DEM study:

i) Contour map of the plant area with contour interval of 0.50 m. This map has been prepared using recent grid survey data of the plant area.

ii) Geographic referencing points: These have been extracted from the features common in the toposheet and the map based on recent topographic survey and georeference points provided by M/S NTPC Limited.

iii) Survey of India Toposheet (1: 50000 scale): Toposheet Number 73 E/2 and 73 E/6 of year 1978-79.

iv) Plant layout map showing location and ground formation levels of various components of the Patratu Super Thermal Power Project (STPP) Phase-I(3 × 800 MW).

3.2 PROCEDURE FOR DIGITAL ELEVATION MODEL (DEM)

ARC-GIS software has been used for preparation of the DEM. Each contour was assigned its value and converted into TIN.

Different component of the Patratu Super Thermal Power Project (STPP) are shown in Figure 3.1

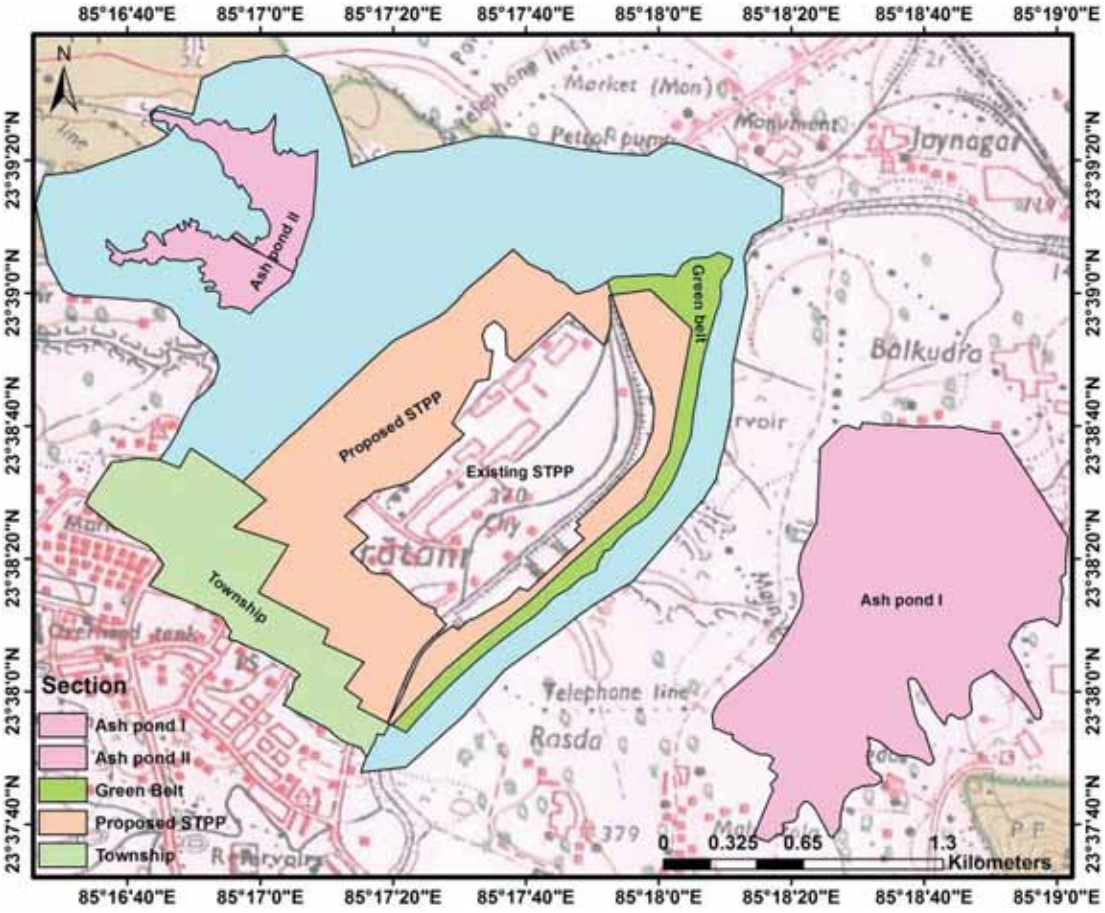


Figure 3.1: Different components of the Patratu Super Thermal Power Project (STPP)

The contours in shape file have been interpolated to obtain digital elevations of the equally sized gird cells. Size of a grid cell is 0.5 m × 0.5 m in this study. The DEM of the study area i.e. plant, ash pond 2 is shown as contour zoning map in Figure 3.2 and elevation variation from 349.18 m to 396.23 m is depicted through different colours. The DEM of the study area is also shown as single colour intensity map in Figure 3.2b.The DEM of the plant and ash pond is also presented separately in Figure 3.3 and Figure 3.4 respectively.

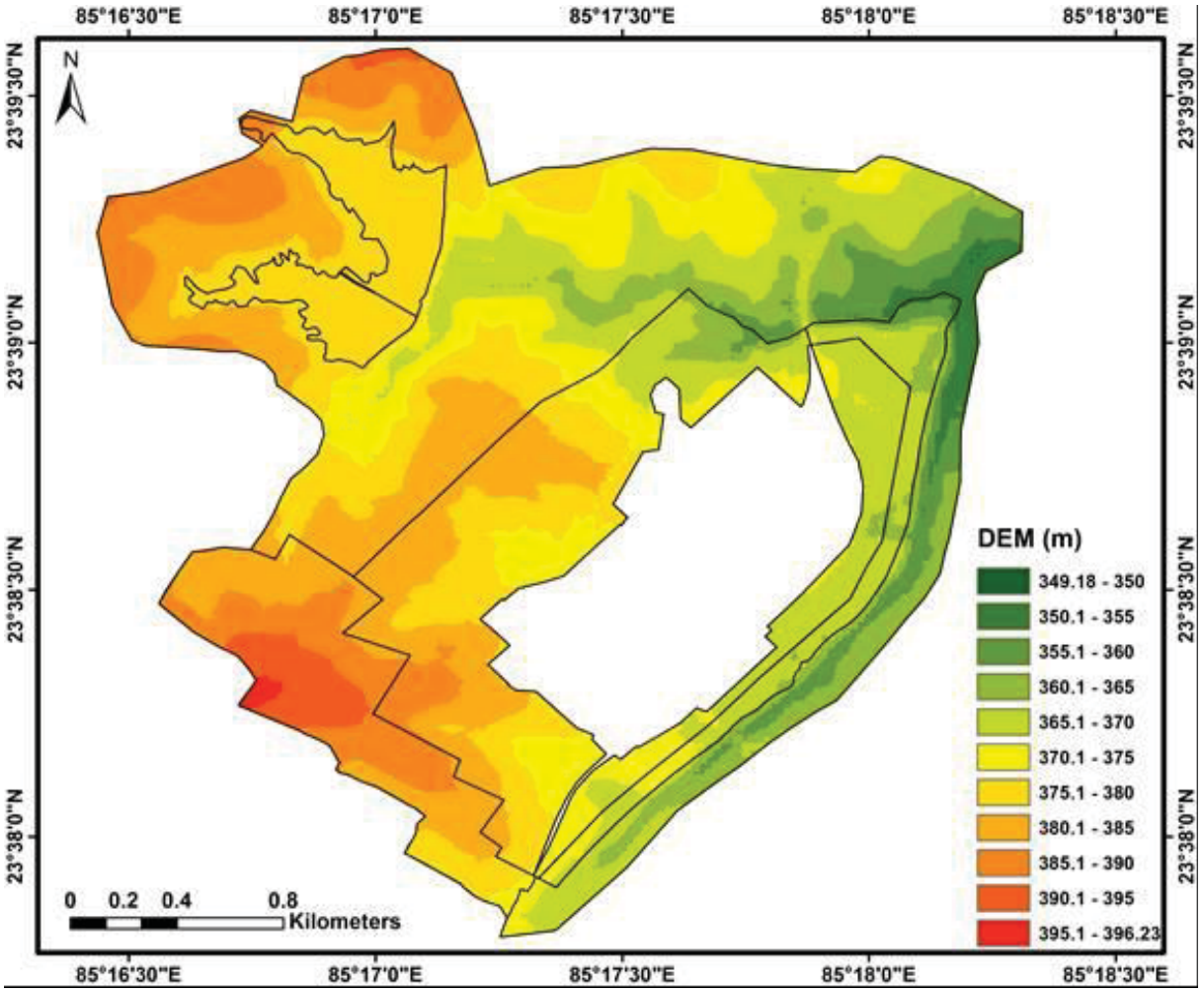


Figure 3.2a: DEM - contour zonation map of the study

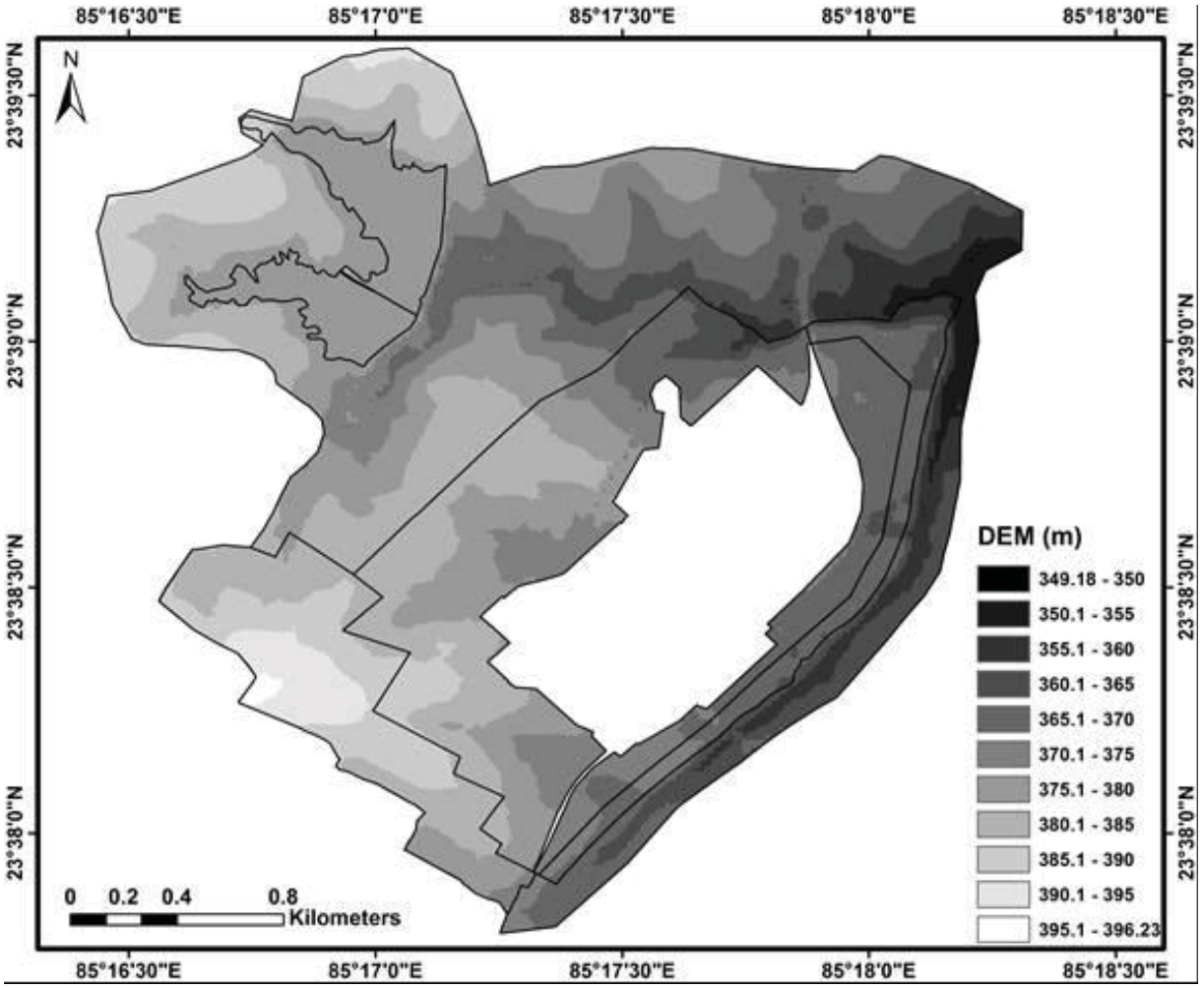


Figure 3.2b: DEM - terrain colour intensity map of the study area

3.2.1 DEM of the plant area

Figure 3.3 show that the North part of the study area has lowest elevation of 357.5 m. The centre part of the study area has an elevation of 380.5 meter. The South West part of the study area has highest elevations of 388.9 m. The North West part of the study area has elevation in the range of 366.0 m to 375.0 m. North Eastern part of the study area has an elevation of 376 m to 380 m. These elevations will provide a guideline for economizing the cost of earth work during the design of plant.

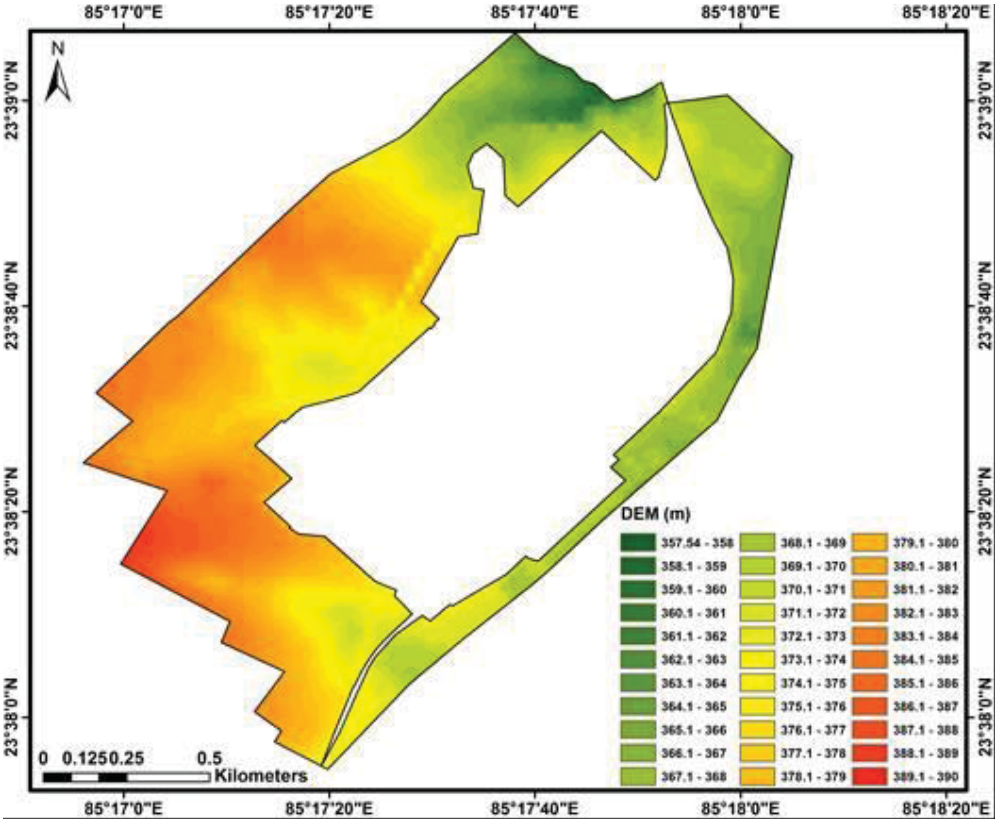


Figure 3.3: DEM - contour zonation map of the plant area

3.2.2 DEM of the ash pond area

3.2.2a DEM of the ash pond area 2

Figure 3.4a show that the north eastern part of the Ash pond area has lowest elevation of 376 m. The North western part of the study area has highest elevation of 388 m. These elevations will provide a guideline for economizing the cost of earth work during the design of Ash pond.

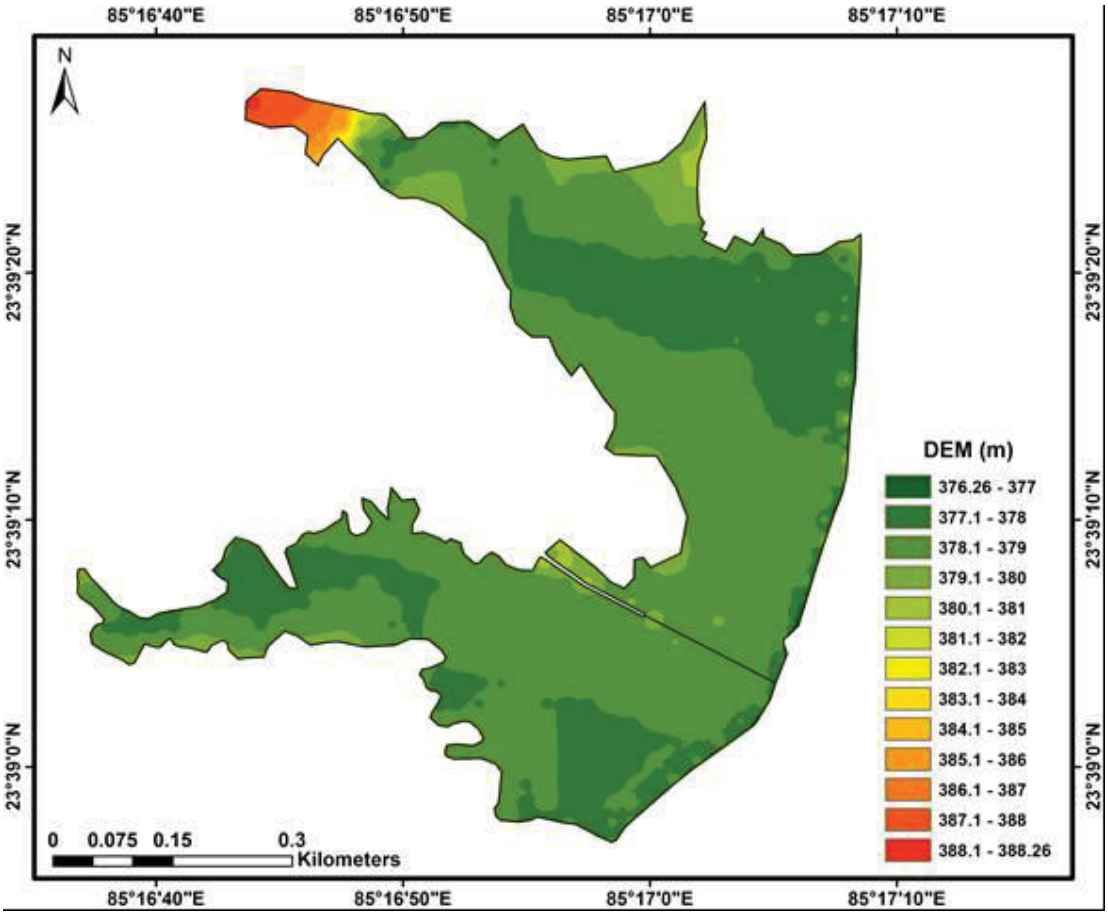


Figure 3.4a: DEM - contour zonation map of the ash pond 2 area using surveyed topographical data

3.2.2b DEM of the ash pond 1

Figure 3.4b show the variation in elevation from 356 m to 391 m in the ash pond 1 area. North-eastern part of the Ash pond area has lowest elevation of 356.0 m. The south-eastern part of the ash pond area has highest elevation of 391 m.

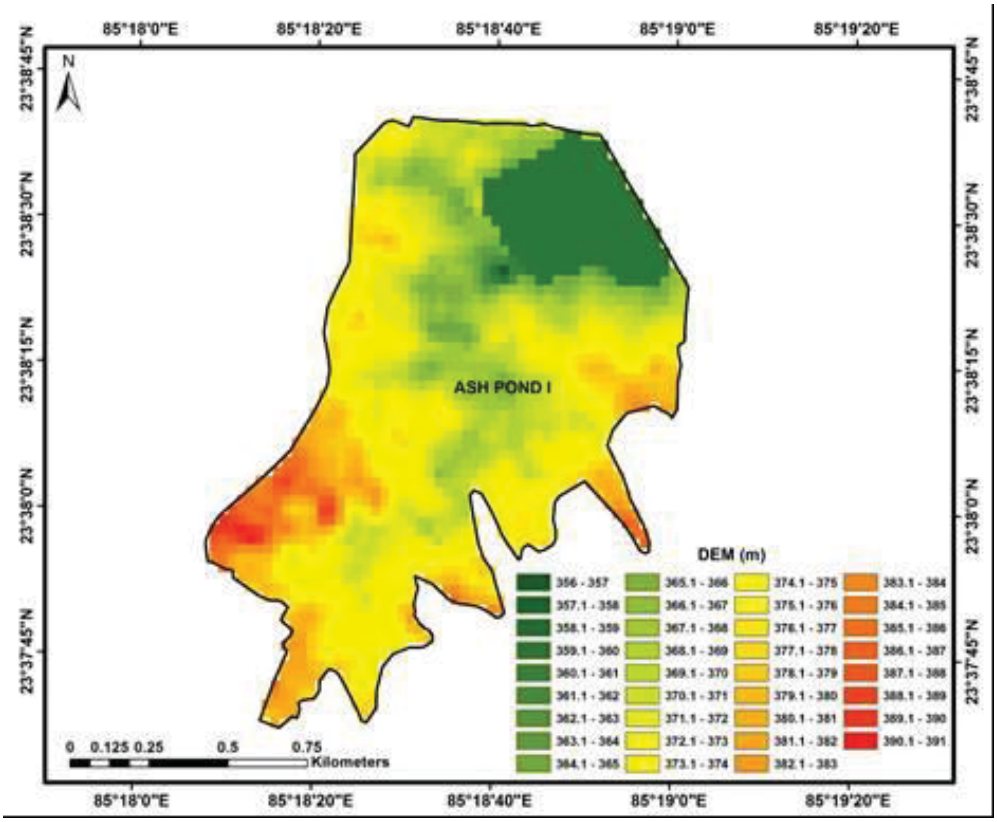


Figure 3.4b: DEM - contour zonation map of the ash pond 1 area using SRTM DEM datasets

3.2.3 DEM of the Green belt area

Figure 3.5 show that the southern part of the Green belt area has highest elevation of 374 m. The Northern part of the study area has lowest elevation of 350 m.

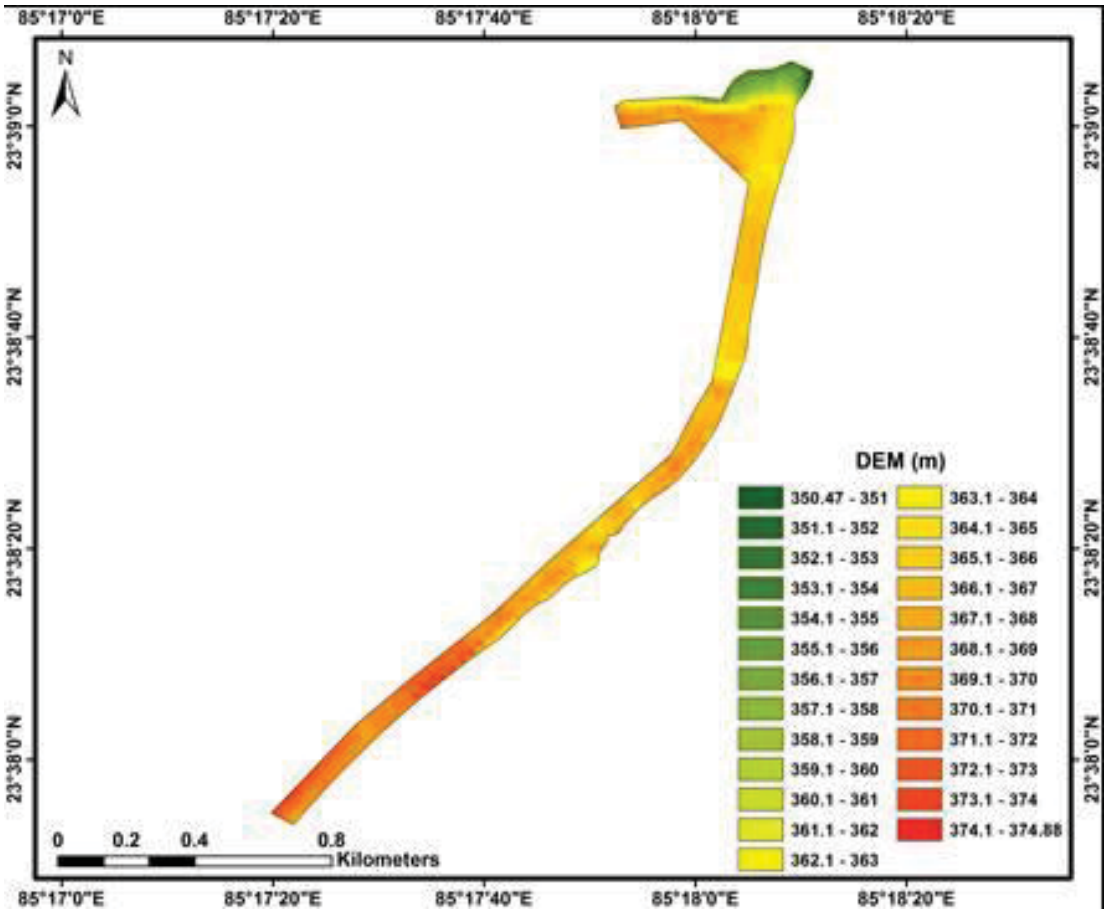


Figure 3.5: DEM - contour zonation map of the Green belt area

3.2.4 DEM of the colony area

Figure 3.6 show that the north eastern part of the colony area has lowest elevation of 372 m. The South western part of the study area has highest elevation of 395 m.

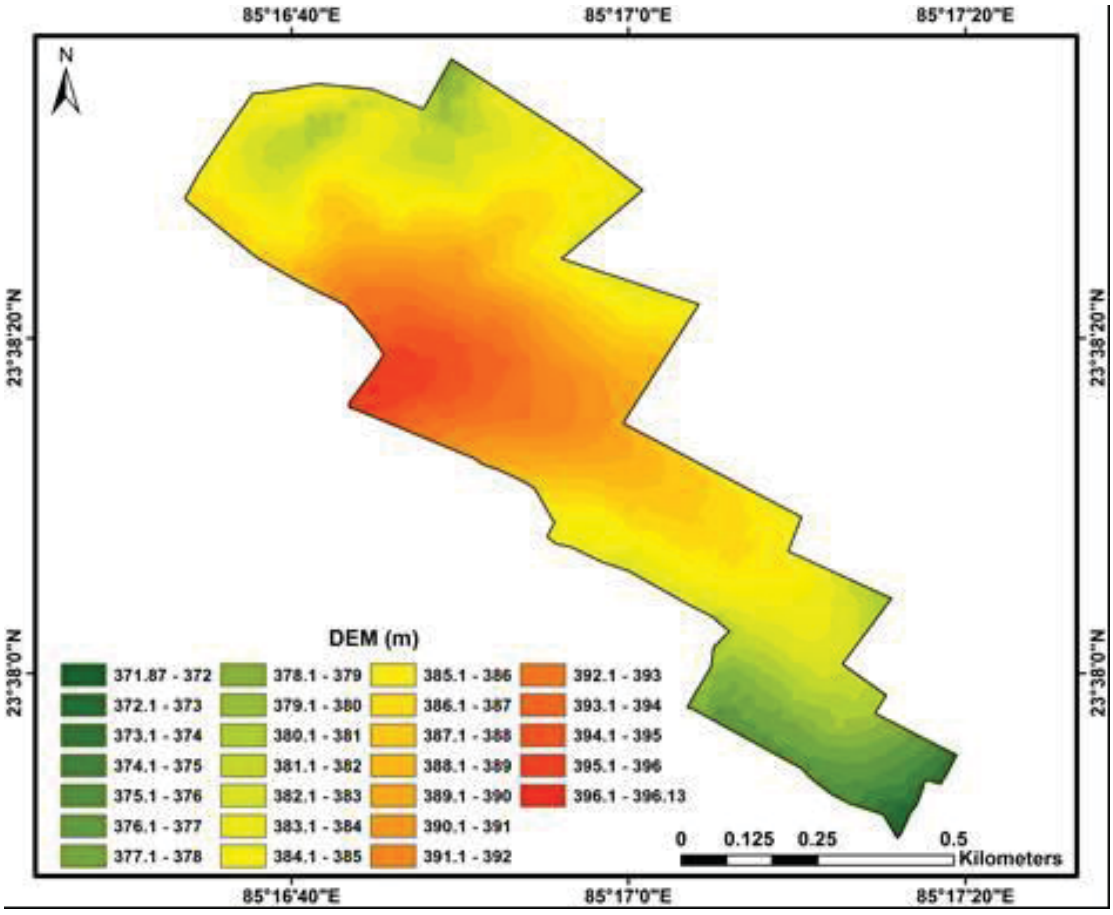


Figure 3.6: DEM - contour zonation map of the Colony area

3.3 GENERATION OF STREAM NETWORK

The Spatial analyst tools of ARC-GIS software has been used in the present study for further processing in the context of stream generation.

DEM has been smoothened out for eliminating uneven irregularities using Fill tool to remove the sinks. Corrected DEM has been used to generate pattern of flow directions and for identification of flow accumulation through each pixel of given elevation. Generated information on flow pattern and flow accumulation considers Eight-Point Pour model for the purpose of computing flow directions for use in basin delineation with DEMs directions. With the flow directions assigned for each DEM point, the flow accumulation at each DEM point has been computed. The flow accumulation at a given DEM point is defined as the number of earlier DEM points whose flow paths eventually pass through that point.

Streams are identified by large values of flow accumulation since the flow paths of many points pass through the stream points. Outlet of a watershed has the highest value of flow

accumulation of any of the DEM points since the flow paths of all points in the watershed will eventually pass through the outlet point. Streams have been identified by displaying all DEM points with a flow accumulation value of more than 500. Figure 3.7a and b shows the generated stream network in the study area.

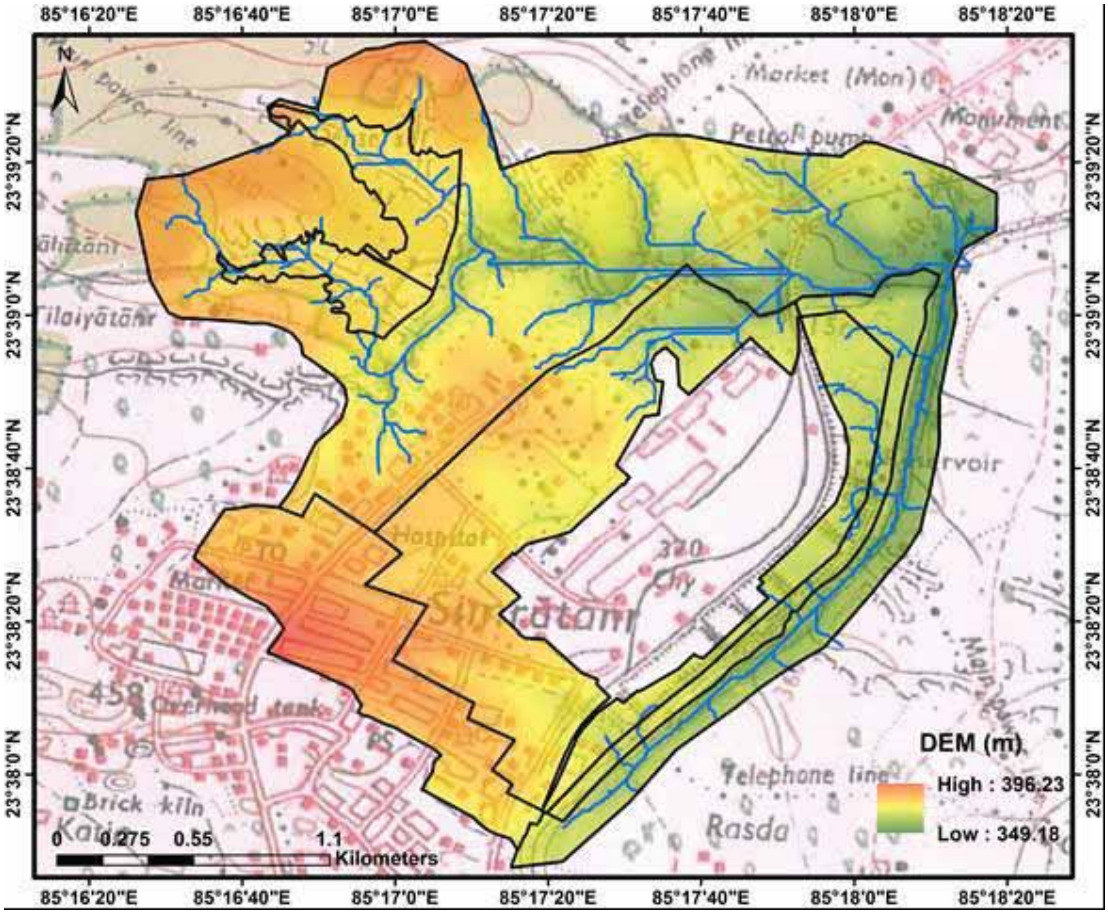


Figure 3.7a: Drainage network derived from DEM

Drainage network created from DEM was overlaid with the toposheet drainage network (Figure 3.7 b). It is evident from the Figures 3.7 that major drainage of the study area is matching with the drainage created from DEM. Drainage of the area has not much changed over the time period. Overlaid DEM and toposheet is also presented in Fig.3.7c.

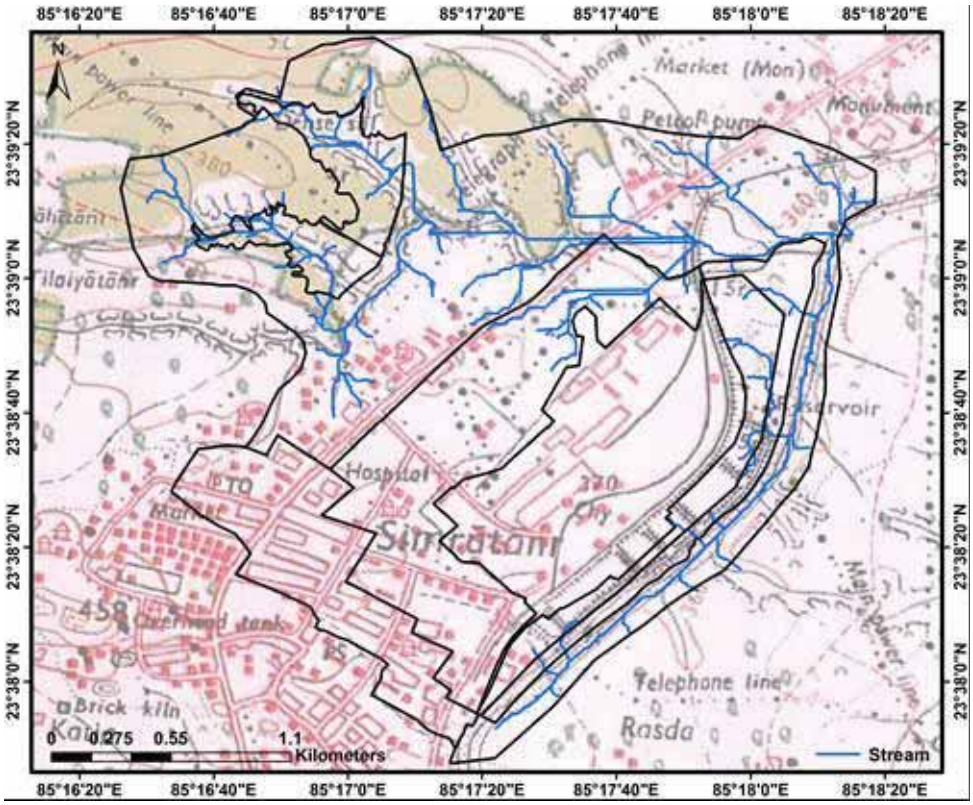


Figure 3.7b: Comparisons of drainage network from toposheets drainage

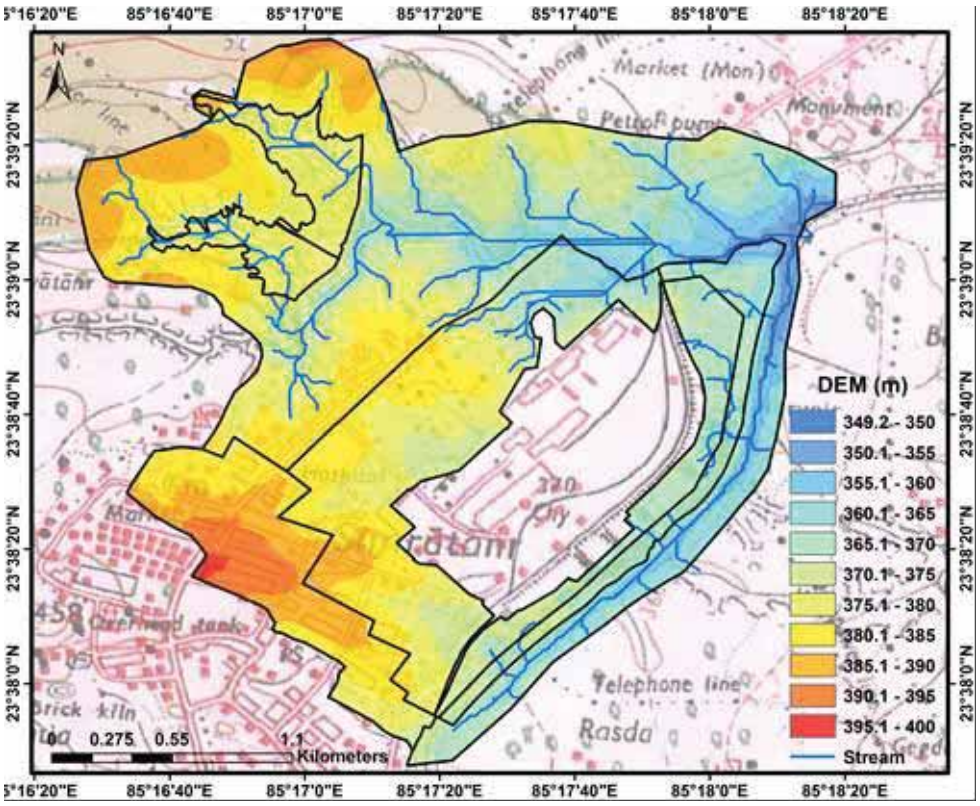


Figure 3.7c: Overlay of DEM and toposheets

3.4 DISTRIBUTION OF LAND AREA IN DIFFERENT ELEVATION

3.4.1 PLANT AREA

The Digital Elevation Model prepared in ARC-GIS has been used to compute the natural drainage area (within plant boundaries) between different elevation ranges. The DEM computes the number of pixels in each interval. Table 3.1 shows distribution of area from 357.54 m to 389 m elevation. The DEM pixel size used in this study is 0.5 m x 0.5 m.

67.65 ha (50.15%) of the plant area lies below 376.0 m elevation and the plant area having elevation higher than 379 m elevation is ha (34.43%).

Table 3.1: Areal distribution with elevation in the plant area and reservoir as per DEM

Elevation	No. of Pixel	Area (m^2)	Area (ha)	Area %	Cumulative Area %	Cumulative Area (ha)
358	361	90.25	0.01	0.01	0.01	0.01
359	5693	1423.25	0.14	0.11	0.11	0.15
360	17272	4318.00	0.43	0.33	0.44	0.58
361	21501	5375.25	0.54	0.41	0.84	1.12
362	33874	8468.50	0.85	0.64	1.48	1.97
363	38924	9731.00	0.97	0.73	2.22	2.94
364	45444	11361.00	1.14	0.86	3.07	4.08
365	57049	14262.25	1.43	1.07	4.15	5.50
366	97214	24303.50	2.43	1.83	5.98	7.93
367	176104	44026.00	4.40	3.32	9.30	12.34
368	272948	68237.00	6.82	5.14	14.44	19.16
369	374621	93655.25	9.37	7.06	21.50	28.53
370	298995	74748.75	7.47	5.63	27.13	36.00
371	170549	42637.25	4.26	3.21	30.35	40.26
372	235944	58986.00	5.90	4.45	34.79	46.16
373	180290	45072.50	4.51	3.40	38.19	50.67
374	215869	53967.25	5.40	4.07	42.26	56.07
375	250624	62656.00	6.27	4.72	46.98	62.33
376	212527	53131.75	5.31	4.00	50.98	67.65
377	222085	55521.25	5.55	4.18	55.17	73.20
378	235268	58817.00	5.88	4.43	59.60	79.08
379	316816	79204.00	7.92	5.97	65.57	87.00
380	319969	79992.25	8.00	6.03	71.60	95.00
381	323509	80877.25	8.09	6.10	77.69	103.09
382	335918	83979.50	8.40	6.33	84.02	111.48
383	314024	78506.00	7.85	5.92	89.94	119.33

384	207752	51938.00	5.19	3.91	93.85	124.53
385	128687	32171.75	3.22	2.42	96.28	127.75
386	92020	23005.00	2.30	1.73	98.01	130.05
387	51723	12930.75	1.29	0.97	98.99	131.34
388	34038	8509.50	0.85	0.64	99.63	132.19
389	18628	4657.00	0.47	0.35	99.98	132.66
389.44	1122	280.50	0.03	0.02	100.00	132.68
Total			132.68	100.00		

Figure 3.8 is graphical depiction of the cumulative area distribution up to different elevation in the plant area. The information derived from the DEM study can be used to arrive at cost effective levels at which different plant components should be finally located. It is recommended that in detailed project planning this aspect may be carefully examined.

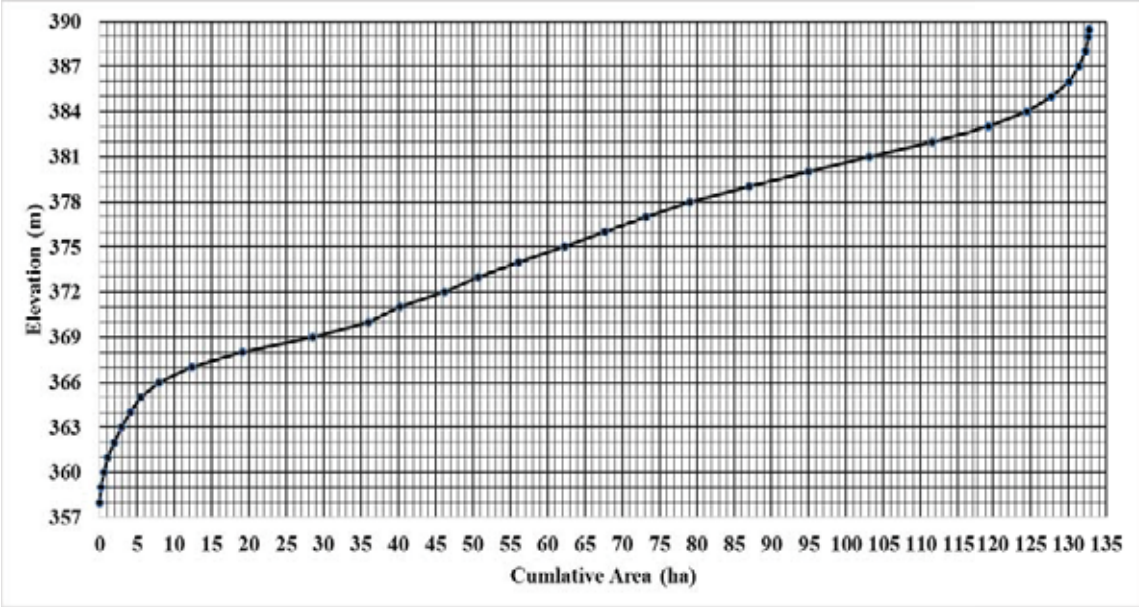


Figure 3.8: Cumulative areal distributions with elevation in plant area

3.4.2a ASH POND (II)

Table 3.2 shows distribution of area in the Ash Pond area from 376.1 m to 388.26 m elevation. The DEM pixel size used in this study is 0.5 m x 0.5 m. Figure 3.9 is graphical depiction of the cumulative area distribution up to different elevation in the ash pond area.

Table 3.2: Areal distribution with elevation in the Ash Pond area as per Survey data

Elevation (m)	No. of Pixel	Area (sq. m)	Area (ha)	Area (%)	Cumulative Area (%)	Cumulative Area (ha)
376.10	3247	811.75	0.08	0.25	0.25	0.08
378.00	373864	93466.00	9.35	29.20	29.46	9.43
379.00	795643	198910.75	19.89	62.15	91.61	29.32
380.00	72209	18052.25	1.81	5.64	97.25	31.12
381.00	9885	2471.25	0.25	0.77	98.02	31.37
382.00	1081	270.25	0.03	0.08	98.11	31.40
383.00	1082	270.50	0.03	0.08	98.19	31.43
384.00	874	218.50	0.02	0.07	98.26	31.45
385.00	1762	440.50	0.04	0.14	98.40	31.49
386.00	4255	1063.75	0.11	0.33	98.73	31.60
387.00	5515	1378.75	0.14	0.43	99.16	31.74
388.00	9781	2445.25	0.24	0.76	99.93	31.98
388.26	953	238.25	0.02	0.07	100.00	32.00
			32.00			100.00

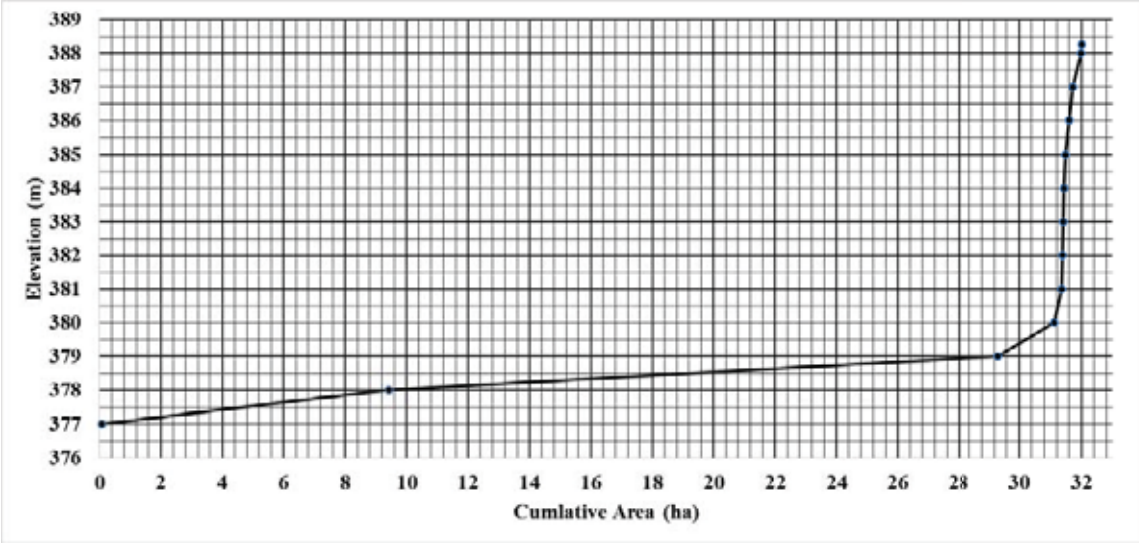


Figure 3.9: Cumulative areal distributions with elevation in ash pond 2 area

3.4.2b ASH POND (I)

Table 3.3 shows distribution of area in the Ash Pond area from 356 m to 391 m elevation. The DEM pixel size used in this study is 30 m × 30 m. Figure 3.10 is graphical depiction of the cumulative area distribution up to different elevation in the ash pond area.

Table 3.3: Areal distribution with elevation in the Ash Pond 1 area as per SRTM DEM

Elevation	No. of Pixel	Area (sq. m)	Area (ha)	Area %	Cumulative Area (%)	Cumulative Area (ha)
356	1	867.64	0.09	0.05	0.05	0.09
360	221	191747.78	19.17	11.84	11.90	19.26
361	4	3470.55	0.35	0.21	12.11	19.61
362	5	4338.19	0.43	0.27	12.38	20.04
363	2	1735.27	0.17	0.11	12.49	20.22
364	3	2602.91	0.26	0.16	12.65	20.48
365	20	17352.74	1.74	1.07	13.72	22.21
366	41	35573.12	3.56	2.20	15.92	25.77
367	80	69410.96	6.94	4.29	20.20	32.71
368	89	77219.70	7.72	4.77	24.97	40.43
369	93	80690.24	8.07	4.98	29.96	48.50
370	113	98042.98	9.80	6.06	36.01	58.31
371	126	109322.27	10.93	6.75	42.77	69.24
372	121	104984.08	10.50	6.48	49.25	79.74
373	118	102381.17	10.24	6.32	55.57	89.97
374	159	137954.29	13.80	8.52	64.09	103.77
375	106	91969.53	9.20	5.68	69.77	112.97
376	93	80690.24	8.07	4.98	74.76	121.04
377	95	82425.52	8.24	5.09	79.85	129.28
378	53	45984.76	4.60	2.84	82.69	133.88
379	69	59866.96	5.99	3.70	86.39	139.86
380	60	52058.22	5.21	3.22	89.60	145.07
381	50	43381.85	4.34	2.68	92.28	149.41
382	33	28632.02	2.86	1.77	94.05	152.27
383	23	19955.65	2.00	1.23	95.28	154.27
384	11	9544.01	0.95	0.59	95.87	155.22
385	26	22558.56	2.26	1.39	97.27	157.48
386	19	16485.10	1.65	1.02	98.29	159.12
387	12	10411.64	1.04	0.64	98.93	160.17
388	6	5205.82	0.52	0.32	99.25	160.69
389	5	4338.19	0.43	0.27	99.52	161.12
390	7	6073.46	0.61	0.38	99.89	161.73
391	2	1735.27	0.17	0.11	100.00	161.90
			161.90			

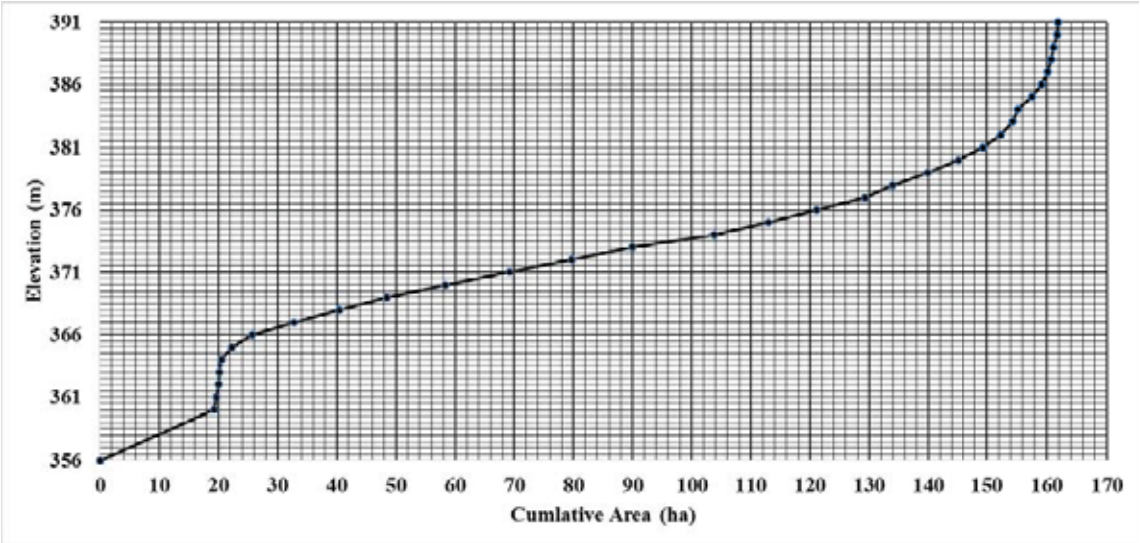


Figure 3.10: Cumulative areal distributions with elevation in ash pond 1 area

3.4.3 COLONY AREA

Table 3.4 shows distribution of area in the Colony area from 371.87 m to 396.23 m elevation. The DEM pixel size used in this study is 0.5 m x 0.5 m. Figure 3.11 is graphical depiction of the cumulative area distribution up to different elevation in the ash pond area.

Table 3.4: Areal distribution with elevation in the Colony area

Elevation	No. of Pixel	Area (m^2)	Area (ha)	Area %	Cumulative Area %	Cumulative Area (ha)
371.87	336	84.00	0.01	0.01	0.01	0.01
373	6527	1631.75	0.16	0.29	0.30	0.17
374	10651	2662.75	0.27	0.47	0.77	0.44
375	17647	4411.75	0.44	0.77	1.54	0.88
376	26371	6592.75	0.66	1.16	2.70	1.54
377	44870	11217.50	1.12	1.97	4.67	2.66
378	48285	12071.25	1.21	2.12	6.79	3.87
379	46981	11745.25	1.17	2.06	8.85	5.04
380	42152	10538.00	1.05	1.85	10.70	6.10
381	66204	16551.00	1.66	2.90	13.60	7.75
382	103746	25936.50	2.59	4.55	18.15	10.34
383	177973	44493.25	4.45	7.81	25.96	14.79
384	221354	55338.50	5.53	9.71	35.67	20.33
385	210134	52533.50	5.25	9.22	44.89	25.58
386	220603	55150.75	5.52	9.68	54.56	31.10

387	193823	48455.75	4.85	8.50	63.07	35.94
388	150908	37727.00	3.77	6.62	69.69	39.71
389	121915	30478.75	3.05	5.35	75.04	42.76
390	110492	27623.00	2.76	4.85	79.88	45.52
391	110216	27554.00	2.76	4.83	84.72	48.28
392	102170	25542.50	2.55	4.48	89.20	50.83
393	85449	21362.25	2.14	3.75	92.95	52.97
394	63961	15990.25	1.60	2.81	95.75	54.57
395	52941	13235.25	1.32	2.32	98.08	55.89
396	42586	10646.50	1.06	1.87	99.94	56.96
396.23	1279	319.75	0.03	0.06	100.00	56.99
				100.00		

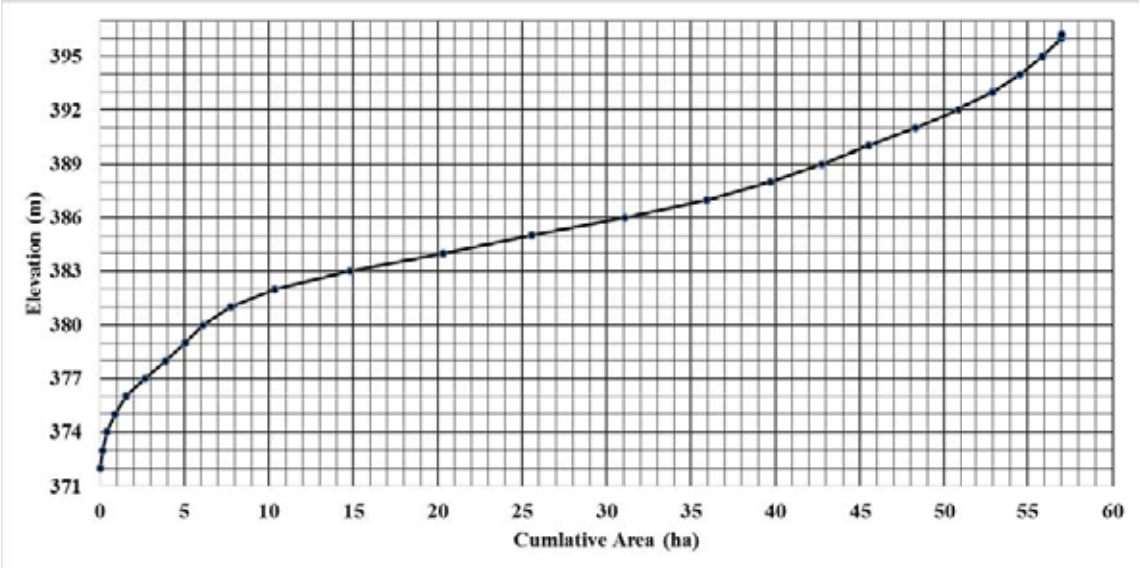


Figure 3.11: Cumulative areal distributions with elevation in colony area

3.4.4 GREEN BELT AREA

Table 3.5 shows distribution of area in the Ash Pond area from 350.47 m to 374.88 m elevation. The DEM pixel size used in this study is 0.5 m x 0.5 m. Figure 3.12 is graphical depiction of the cumulative area distribution up to different elevation in the ash pond area.

Table 3.5: Areal distribution with elevation in the Green belt

Elevation	No. of Pixel	Area (m^2)	Area (ha)	Area %	Cumulative Area %	Cumulative Area (ha)
350.47	372	93.00	0.01	0.04	0.04	0.01
352	2081	520.25	0.05	0.21	0.25	0.06
353	1438	359.50	0.04	0.15	0.40	0.10
354	3078	769.50	0.08	0.32	0.71	0.17
355	12430	3107.50	0.31	1.27	1.99	0.48
356	15674	3918.50	0.39	1.61	3.59	0.88
357	12719	3179.75	0.32	1.30	4.90	1.19
358	9845	2461.25	0.25	1.01	5.91	1.44
359	9656	2414.00	0.24	0.99	6.90	1.68
360	9680	2420.00	0.24	0.99	7.89	1.92
361	9270	2317.50	0.23	0.95	8.84	2.16
362	10855	2713.75	0.27	1.11	9.95	2.43
363	18342	4585.50	0.46	1.88	11.83	2.89
364	26879	6719.75	0.67	2.75	14.59	3.56
365	95753	23938.25	2.39	9.81	24.40	5.95
366	136165	34041.25	3.40	13.96	38.36	9.36
367	145399	36349.75	3.63	14.90	53.26	12.99
368	133970	33492.50	3.35	13.73	66.99	16.34
369	125766	31441.50	3.14	12.89	79.88	19.48
370	76728	19182.00	1.92	7.86	87.74	21.40
371	39388	9847.00	0.98	4.04	91.78	22.39
372	48349	12087.25	1.21	4.96	96.74	23.60
373	22022	5505.50	0.55	2.26	98.99	24.15
374	8637	2159.25	0.22	0.89	99.88	24.36
374.88	1196	299.00	0.03	0.12	100.00	24.39
Total			24.39			

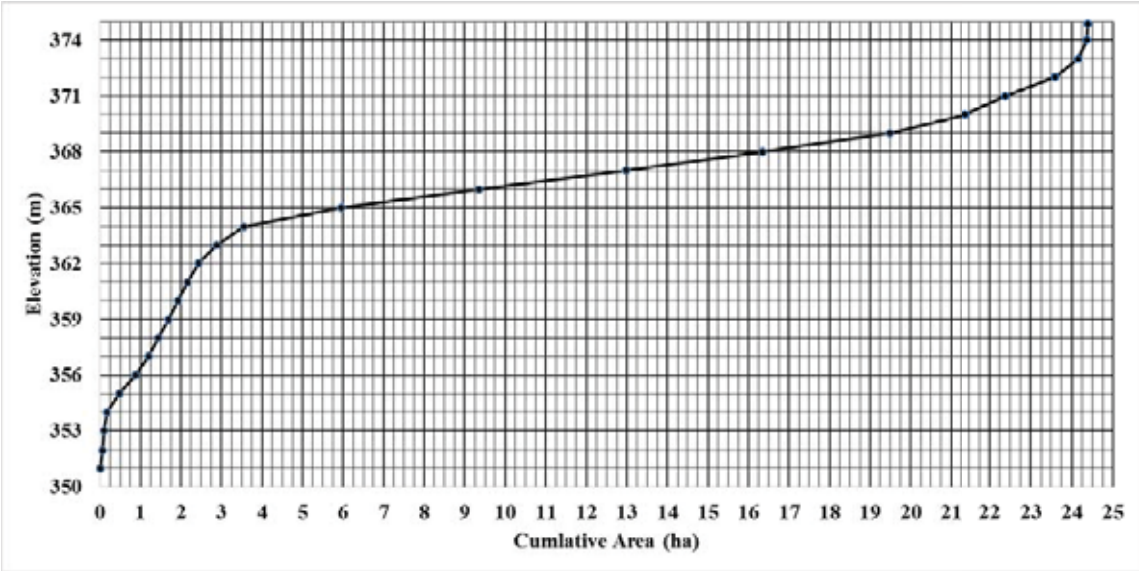


Figure 3.12: Cumulative areal distributions with elevation in Green belt area

CHAPTER 4

DESIGN STORM SCENARIOS OF VARIOUS RETURN PERIODS

Design storm and flood scenarios are required for (i) planning of drainage in the plant area and vicinity and (ii) for assessing possible submergence in the plant area from internal and external flooding.

The time distribution of storm rainfall of a given duration is the main input in deciding the flood peak and the shape of the flood hydrograph. This input has to be converted into excess rainfall and convoluted with synthetic unit hydrograph to obtain a flood hydrograph with addition of base flow. This chapter covers estimation of storm rainfall of various return periods.

4.1 FREQUENCY ANALYSIS OF 1-DAY ANNUAL MAXIMUM RAINFALL

Daily rainfall data are available at Ranchi from 1971 to 2011 (41 years). 1-Day annual maximum rainfall series was constructed and EV Type I probability distribution was applied (table 4.1a). Figure 4.1 shows graphical frequency analysis of 1-Day annual maximum rainfall at Ranchi.

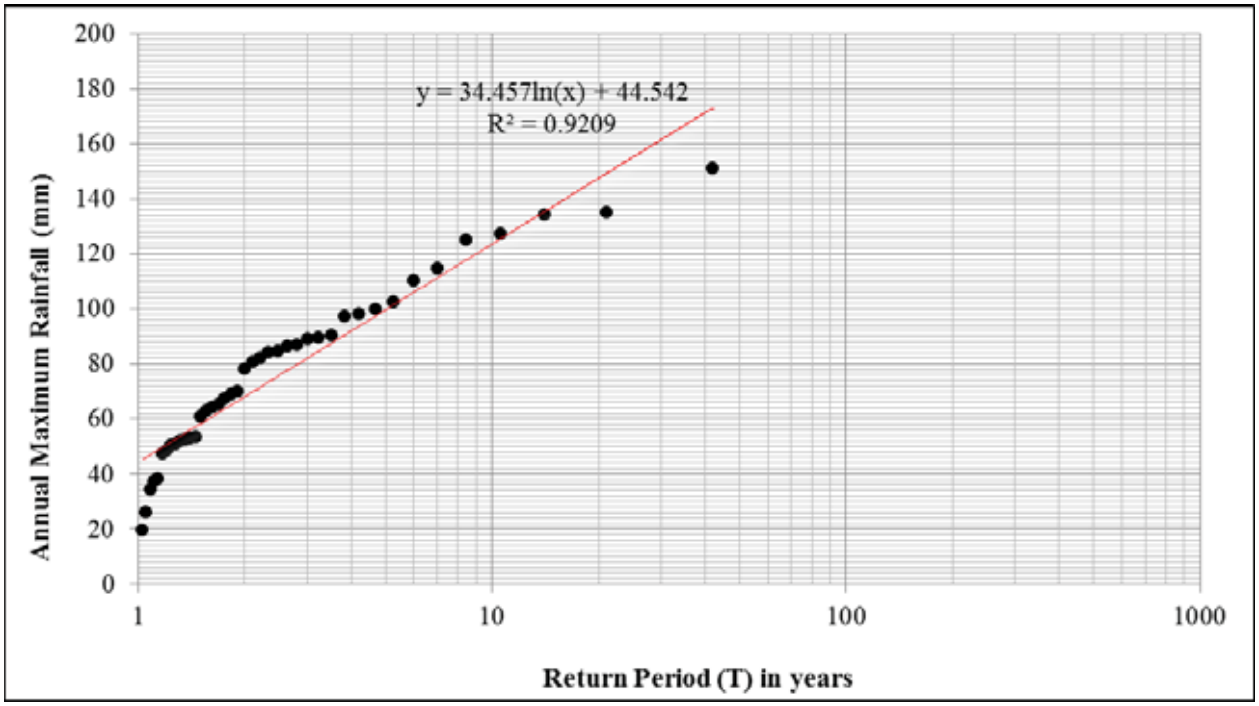


Figure 4.1: EV Type I Graphical frequency analysis of 1-Day annual maximum rainfall at Ranchi

1-Day rainfall has been converted to 24 hr rainfall using a factor of 1.15 (as per CWC report Nov.1994). 1-day rainfall and corresponding 24 hr rainfall for various return periods are given in table 4.1b.

Table 4.1a: Frequency analysis of rainfall data

Year	Maximum Rainfall (mm)	Rank	Probability of occurrence (P)	Return period (T)
1973	151.4	1	0.02	42.00
2008	135.2	2	0.05	21.00
1994	134.2	3	0.07	14.00
1998	127.5	4	0.10	10.50
2011	125.2	5	0.12	8.40
1999	114.9	6	0.14	7.00
1995	110.3	7	0.17	6.00
2009	102.6	8	0.19	5.25
1985	99.8	9	0.21	4.67
1988	98.4	10	0.24	4.20
1996	97.2	11	0.26	3.82
1971	90.4	12	0.29	3.50
2003	89.8	13	0.31	3.23
1976	89	14	0.33	3.00
2007	86.9	15	0.36	2.80
1989	86.6	16	0.38	2.63
1978	84.9	17	0.40	2.47
2006	84.4	18	0.43	2.33
1997	82.3	19	0.45	2.21
1980	80.9	20	0.48	2.10
1974	78.5	21	0.50	2.00
1993	70.2	22	0.52	1.91
1975	69.4	23	0.55	1.83
2004	67.6	24	0.57	1.75
1984	65.5	25	0.60	1.68
2002	64.6	26	0.62	1.62
1982	63.1	27	0.64	1.56
1972	61	28	0.67	1.50
1987	53.5	29	0.69	1.45
2000	53	30	0.71	1.40
1991	52.6	31	0.74	1.35
1983	52.3	32	0.76	1.31
2001	50.8	33	0.79	1.27
1981	50.6	34	0.81	1.24
1977	48.8	35	0.83	1.20
1986	47.3	36	0.86	1.17
1992	38.5	37	0.88	1.14
1990	37.7	38	0.90	1.11
1979	34.6	39	0.93	1.08
2010	26.1	40	0.95	1.05
2005	19.7	41	0.98	1.02

Table 4.1b: One day rainfall (mm) of various return periods

Station	Return period (Years)				
	10	**25**	**50**	**100**	
1-Day rainfall at Ranchi (mm)	124	154	175	202	
24 hr. rainfall (mm)	143	177	201	232	

4.2 REGIONAL DEPTH DURATION FREQUENCY STUDIES

The study area lies in Lower Ganga Plains Sub Zone defined by Central Water Commission (CWC 1994). India Meteorological Department (IMD) has conducted detailed rainfall study for lower Ganga Plains Sub Zone (CWC 1994) utilizing the data of 49 self recording raingauge stations and 173 ordinary raingauge stations maintained by IMD/States and 24 self recording rainguages of Railways. The Upper Damodar Valley area covered by the subzone provides well distributed SRRG data of 26 stations in 4 districts of Bihar (now Jharkhand)

The annual maximum series of 1 day rainfall were formed for all the ordinary raingauge stations. These annual extreme value series were subjected to frequency analysis using Gumbel's extreme value probability distribution and 1 day rainfall estimates corresponding to 25,50 and 100 years return period were computed. The daily values of 25 year,50 year and 100 year return period rainfall estimates were converted to 24 hr rainfall estimate using a factor of 1.15. These 24 hour rainfall estimates for all the stations in the sub-zone were plotted on base map and isopluvial maps of 25 year,50 year and 100 year return periods were drawn.

4.3 RECOMMENDATION

The 24 hr rainfall of various return periods based on rainfall data at at Ranchi are shown in Table 4.1b. 24 hr rainfall of 25 year,50 year and 100 year return period as per isopluvial map are similar to 24 hr rainfall estimates as per frequency analysis of 41years data at Ranchi as shown below.

24 hour rainfall (mm) of various return periods as per Ranchi data and as per CWC maps

Return Period	Based on 41 Yrs recent data at Ranchi	Based on CWC maps
25	177 mm	200 mm
50	201mm	240 mm
100	232 mm	260 mm

It is recommended that the 24 hr storm rainfall values obtained from frequency analysis of 41 years rainfall data at Ranchi be used in further analysis as the station is close to the study area and data of recent period (1971 to 2011) and of sufficient length (41 years) have been used in the frequency analysis.

4.4 DESIGN STORM SCENARIOS

Conversion of 24 hour Rainfall into Short Duration Rainfall

The ratios of 10 year rainfall of short durations of 1 hr,3 hr, 6 hr, 9 hr, 12 hr, 15 hr, 18 hr and 24 hr (as per CWC report 1994) with respect to 24 hr rainfall are given in table below. CWC has recommended that these ratios for 10 year rainfall (as per CWC 1994) are applicable to storm rainfall of other return periods also.

Table 4.2: Average ratio (t hr rainfall/24 hr point rainfall) for various durations

Storm duration (hrs)	1	3	6	9	12	15	18	24
Ratio	0.35	0.515	0.64	0.735	0.8	0.86	0.915	1.0

Conversion of Point to Areal Rainfall

The hourly rainfall data of 26 SRRG stations in the Upper Damodar Valley were used to find the ratios for different duration of storms and for different size of catchments. Detailed procedure is given in CWC (1994). The area reduction factors (ARF) for different catchment areas and for different duration of storms (1 hr, 3 hr, 6 hr , 12 hr and 24 hr duration) are given in Table 4.3 below:

Table 4.3: Point to areal rainfall ratios (percentages)

Area Reduction Factor (%)					
Area (Sq. km)	**1 hour**	**3 hour**	**6 hour**	**12 hour**	**24 hour**
50	94.0	96.54	97.75	98.0	98.75
100	89.0	93.5	95.75	96.25	97.75
150	85.5	90.5	93.75	94.75	96..75
200	-	88.0	91.75	93.0	95.75
250	-	85.5	89.75	91.75	94.75

T-year, 24-hour rainfall values for the study area as recommended earlier (Table 4.1b) has been used for estimation of flood using regional flood formula and rational method as discussed in next chapter. M/S NTPC have desired that internal drainage be planned for 25 year flood and possibility of external flooding in the plant area due to floods in the streams in the vicinity be checked for 100 year flood.

CHAPTER 5

DESIGN FLOOD ESTIMATION AND EXTERNAL FLOODING

5.1 CRITERIA FOR DESIGN FLOOD

Design flood estimation is required for two purposes:

i) For planning of internal drainage in the plant area so as to safely discharge the flood caused by design storm rainfall.

a) For assessing flooding and diversion of existing drains

In the context of design flood, CWC Manual on Estimation of Design Flood (2001) states that "*for very important structures upstream like power house, mines etc., levels corresponding to SPF or PMF may be used; for other structures consideration of smaller design floods and corresponding levels attained may suffice. In general, a 25 year flood for land acquisition and 50 year flood for built up property acquisition may be adopted'. For very important facilities like power houses, normally damage due to physical flooding may not be allowed but disruption of operation may be allowed".*

CWC Manual further states that for road and rail bridges criteria as laid down in Indian Road Congress IRC-5:1998 Section 1 and Indian Railway Standards-1963 may be followed.

Waterway of bridge	50 yr. Return period flood discharge from any other recognized method applicable for that area. Max. discharge fixed by judgement of engineers with comparison of following methods: discharge found by area velocity method, and by unit hydrograph method.
For Railway bridges	50 year flood for smaller bridges carrying railways of lesser importance like minor lines and branch line. 100 year flood for larger bridges carrying main lines and very important rail lines

According to norms of Central Electricity Authority the main plant area should preferably above HFL, the ash pond area could be low lying.

Based on past experience, M/S NTPC have decided that the internal drainage inside the plant area may be planned for 25 year flood and external flooding due to floods in the streams in the vicinity be checked for 100 year flood.

Following recommendations are made regarding design floods for various purposes.

(i) A flood of 25 year return period may be adopted for design of internal drainage channels in the plant area.

(ii) A flood of 100 year return period may be adopted for checking that plant area is safe due to a flood of 100 year return period occurring in streams in the vicinity

5.2 POSSIBILITY OF EXTERNAL FLOODING

Figure 5.1 shows location of existing and proposed plant area, township and the two ash ponds.

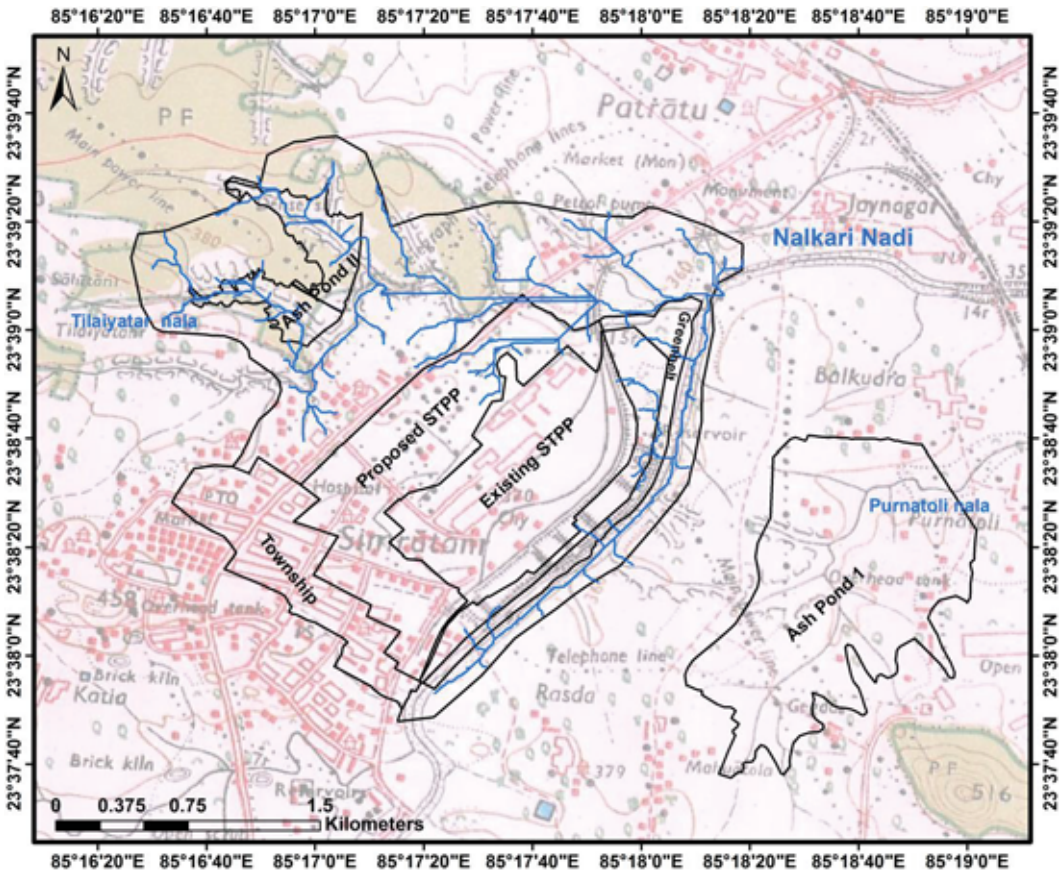


Figure 5.1: Location of existing and proposed plant area, township and the two ash ponds

5.2.1 Natural Drainage in vicinity of Plant Area and Ash Dykes

Natural drainage pattern in the study area within ten Km radius has been discussed in chapter 3. Here the focus is on the flooding in plant area due to flow of flood water in natural drains in vicinity of the plant. Figure 5.2 shows the natural drainage in vicinity of the existing and proposed plant.

Nalkari River: The existing Patratu power plant and the proposed plant lie adjacent to Nalkari river in downstream of the Nalkari reservoir.

Tilaiyatar nala : It passes through the ash dyke-II area. The Tilaiyatar nala joins Nalkari river on its left bank beyond the eastern boundary of the railway track. Just upstream of the confluence and in between the Nalkari river and the Tilaiyatar, there is sizeable open land.

SY nala: Another nala passes through the proposed site of main plant area. It is named SY nala for the sake of discussion. SY nala joins the Tilaiyatar nala coming from Ash dyke–II area. The SY nala is proposed to be diverted and covered with RCC box of suitable section.

Purnatoli nala: A nala passes through the ash dyke-I area which is located on the right bank side of Nalkari river. It is named after the nearby Purantoli village for the sake of discussion. The Purnatoli nala joins Nalkari river on its right bank.

5.2.2 Flood Control Due to Impounding of Flood Water by Nalkari Dam

Nalkari (a southern tributary of Upper Damodar river) is the major stream in vicinity of the power plant. Due to impounding of flood water by the Nalkari dam, flood water in Nalkari river in the downstream is greatly reduced. Nalkari river flow is controlled by operation of the Nalkari reservoir. Therefore flooding in the vicinity of the plant site under natural conditions does not occur. Flooding can occur in vicinity of plant area only in case of dam breach for which a separate dam break study may be carried out. The following discussion on historical flood level is useful to understand as to why external flooding in plant area is not possible now.

The Nalkari river attained the maximum flood level of 367.5 m near Patratu power plant site in the year 1958 prior to construction of the Nalkari dam. The dam was constructed during the period 1962-1968. The Patratu reservoir has helped in significant reduction in flood water level in the downstream of the dam. Thus flood levels in vicinity of power plant are expected to be much lower than the maximum flood level which occurred in the year 1958 prior to construction

of the Nalkari dam. The proposed FGL in plant area and town ship vary from372.0 m(in space for switch yard) to 382.0 m in township area which are much higher than the maximum flood level of 367.5 m prior to construction of the Nalkari dam.

The natural ground level in ash pond area-II vary from 376.26 to 388.26. These elevations are much higher than the flood level in the natural streams in vicinity. Figure 5.3 shows the flood level of 367.5 m in area around plant site

However due to siltation in reservoir over a long period, effectiveness of reservoir in flood moderation would decrease. The dam is now 50 year old. The gross storage capacity of the reservoir was 110.7 MCM at FRL of 406.152 m. In an earlier study by IIT Roorkee, capacity survey of Nalkari reservoir was carried out using remote sensing data. The capacity survey was carried out for the period 2006 to 2012 for the zone of reservoir level fluctuation between 387.096 m to 406.152 m. The original live storage capacity of 110.73 MCM reduced to 89.96 MCM (i.e. by 11.76 %) over the period of 44 years from 1968 (the year of construction) till the year 2012.

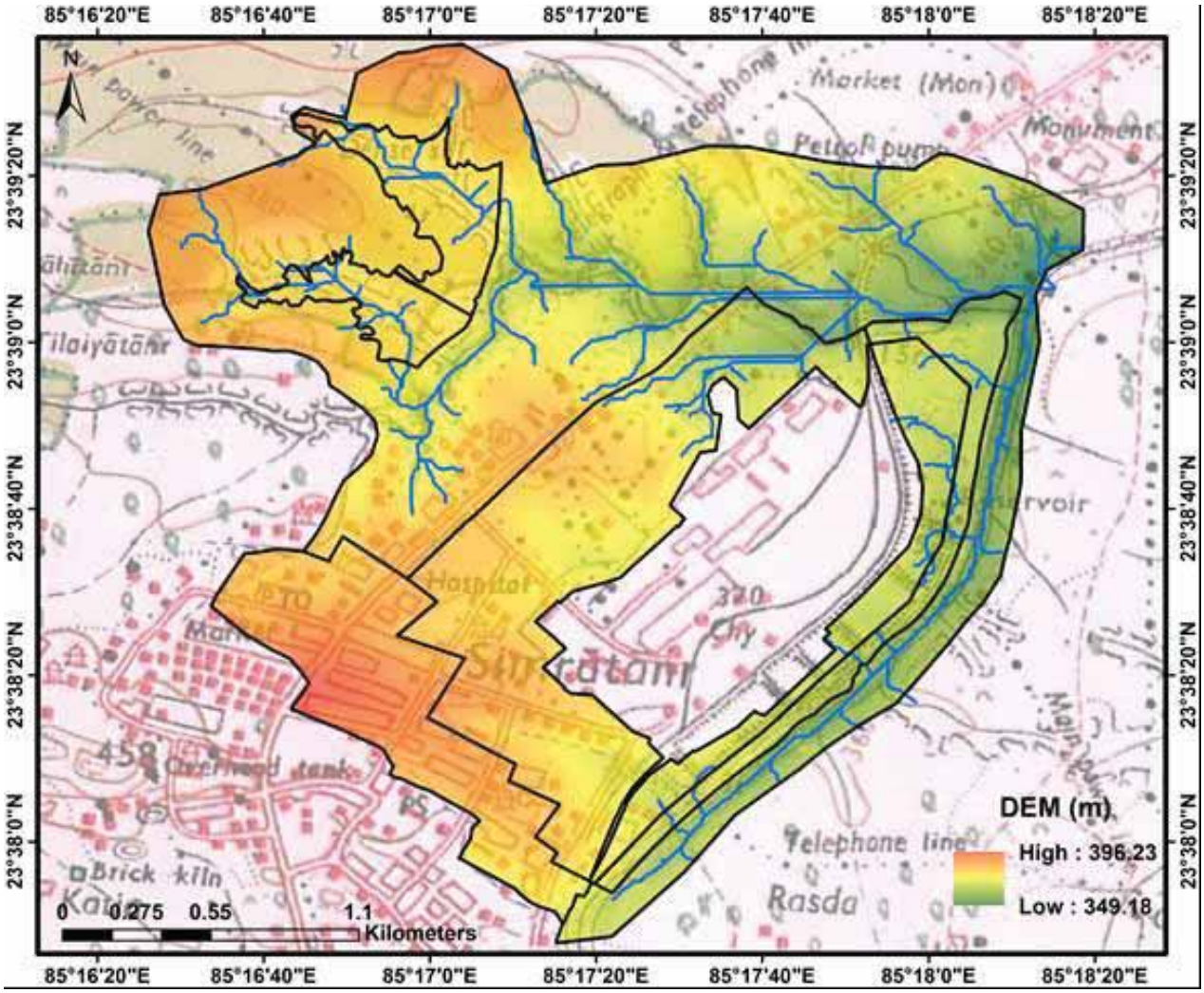


Figure 5.2: Natural drainage in vicinity of plant area HFL 367.5 m (year 1958)

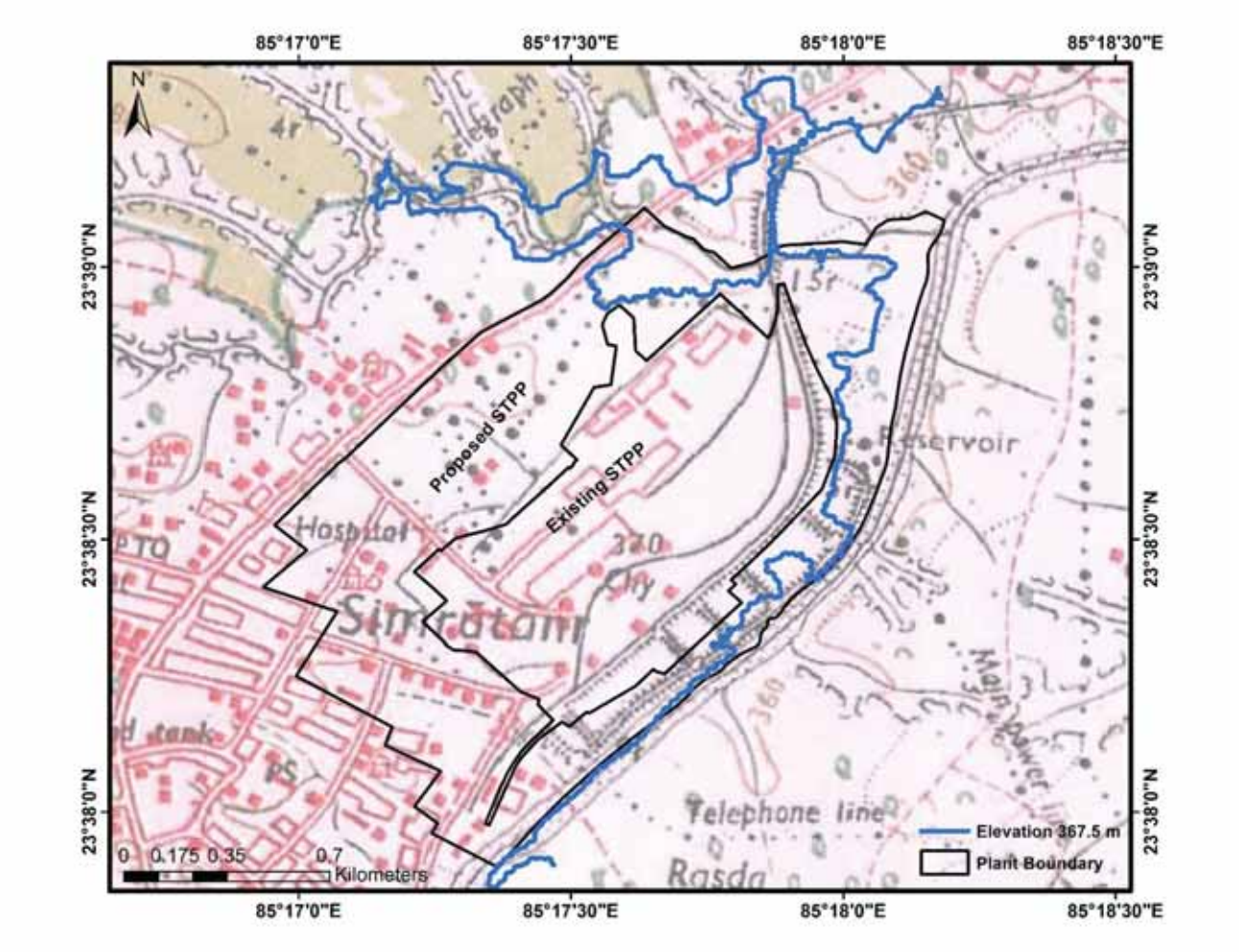


Figure 5.3: Topography of plant area and HFL 367.5 m (Flood in year 1958)

5.2.3 Flooding in Plant Area Due to SY Nala

This nala passes through the proposed site of main plant area. It joins the Tilaiyatar nala coming from Ash dyke–II area. The SY nala is proposed to be diverted and realigned in west- east direction between the existing switch yard and proposed main plant area.

In the following paragraphs,100 year flood in the SY nala has been estimated to assess possibility of flooding under existing conditions in the vicinity of the SY nala.

5.3 METHODS FOR FLOOD ESTIMATION

The study area lies in the hilly region of Upper Damodar Valley. Following two regional regression models are relevant for the present study:

5.3.1 Method-I: Regional Flood Frequency Model of CWC

Central Water Commission Manual on Estimation of Design Flood (CWC, 1994) provides a regional flood frequency model for the sub zone which is based on multiple regression correlation of flood peaks with physiographic parameters and 24 hour point rainfall of T year return period. The proposed relationships for hilly region of the subzone are:

for return period of 25 year:

$Q_{25} = 0.831\ (A)^{0.883}\ (L)^{-0.389}\ (S)^{0.132}\ (R_{25})^{1.117}$

r=0.998 and S.E.=1.059

for return period of 50 year:

$Q_{50} = 1.32\ (A)^{0.871}\ (L)^{-0.359}\ (S)^{0.106}\ (R_{50})^{0.968}$

r=0.999 and S.E.=1.046

for return period of 100 year:

$Q_{100} = 0.614\ (A)^{0.889}\ (L)^{-0.405}\ (S)^{0.109}\ (R_{100})^{1.22}$

R=0.999 and S.E.=1.039

where,

L : length of longest stream course (km)

A : catchment area in km^2

S : equivalent slope in m/km

R_T: 24 hour point rainfall in cm corresponding to T yr return period

For the SY nala;

L=1.4728 km; A=0.77 km^2 ;S=10.08 m/km

R_{25} 17.7 cm; R_{50}=20.1 cm and R_{100}=23.2 cm

Estimates of Q_{25} , Q_{50} and Q_{100} are given in Table 5.2.

5.3.2 Method II: Rational Method for Small Catchments

For catchments of area less than 25 sq km, the method given in the following document is recommended by Central Water Commission(CWC 1994).

Report No RBF-16 'Flood Estimation Methods for Catchments Less Than 25 Km^2 in Area' prepared by Research, Design &Standards Organization(RDSO) of Indian Railway, Government of India

This report explains the modified rational method for estimation of flood for catchments of area less than 25 sq km. The Rational equation is the simplest method to determine peak discharge from drainage basin runoff. It is the most common method used for sizing sewer systems. Rational Equation in metric units is given below.

$Q=0.278CIA$

Where, Q = Peak discharge, cubic meter per second; C= Rational method runoff coefficient; I = Rainfall intensity(mm/hour) during the time of concentration; A = Drainage area(sq km)

Time of concentration (t_c) is the time required for the most distant part of the catchment to contribute to the outflow. Time of concentration has been taken from Bransby-Williams formula as suggested in RBF-16.

$t_c=0.615L/(A^{0.1}S^{0.2})$

where,

t_c=time of concentration (hrs); L=main stream length(km); S=mean slope of main stream(%); A=catchment area(km^2)

The Runoff coefficient (C): It is a function of the soil type, drainage basin slope and land cover and may be taken from the formula given in table 5.1 below:

Table 5.1: Formula to obtain Runoff coefficient C

Sl. No	Description of catchment	Formula for C
1	Sandy soil/sandy loam/arid areas	$C=0.249(R.F)^{0.2}$
2	Alluvium/silty loam/coastal areas	$C=0.332(R.F)^{0.2}$
3	Red soil/clayey loam/grey or brown alluvium/cultivated plains/tall crops/ wooden areas	$C=0.415(R.F)^{0.2}$

4	Black cotton/clayey soil/lightly covered, lightly wooded/plain and barren/ sub montane and plateau	$C=0.456(R.F)^{0.2}$
5	Hilly soils/plateau and barren	$C=0.498(R.F)^{0.2}$

C for hilly soils/plateau and barren is given as

$C=0.498(R.F)^{0.2}$

where, R =T year 24 hour point rainfall(cm) and F=area reduction factor depending upon catchment area and duration of rainfall.

24 Hr Rainfall: In the absence of site specific hydro-meteorological data, regional approach has been adopted to arrive at the design storms of return periods corresponding to 25 years, 50 years and 100 years, as discussed in Chapter 4.

Table 5.2: Flood Estimation in SY nala

	25 year	**25 year**	**100 year**
Catchment area (Km^2)	0.77	0.77	0.77
24 hr rainfall (R) in cm	17.7	20.1	23.2
Length (km)	1.4728	1.4728	1.4728
Slope (S)(%)(10.08 m/km=0.01008 m/m =1.008%)	1.008	1.008	1.008
Area reduction factor for rainfall(F)	0.988	0.988	0.988
Runoff Coef $C=0.498(R.F)^{0.2}$	0.883	0.907	0.931
Design duration (hours)=time of concentration $t_c=0.615L/(A^{0.1}S^{0.2})$=0.928 hr say I hr	1	1	1
Storm rainfall during design duration= Average ratio (t hr rainfall/24 hr point rainfall from table 4.2 in chapter 4)x 24 hr rainfall ==0.35x24 hr rainfall	61.95	70.35	81.2
Rainfall Intensity(I) during duration of rainfall in mm/hr	61.95	70.35	81.2
Flood Estimate method-I Rational Formula Q=0.278CIA (m3/sec)	11.7	13.66	16.18
Flood Estimate method-II Regional Flood Frequency Model of CWC	19.06	21.34	24.79

5.3.3 Recommendation

Flood Estimate using Rational Formula and using Regional Flood Frequency Model of CWC are of similar magnitude. It is recommended to use flood estimate using Rational formula as catchment size is very small for which rational formula is more appropriate as recommended by Central Water Commission(CWC 1994) and by *Research, Design &Standards Organization(RDSO) of Indian Railway, Government of India* (Report RBF 16).

5.4 BANKFUL DISCHARGE IN SY NALA

5.4.1 Longitudinal Sections and Cross Sections of Drains

Topographic map of plant area based on the recent topographic survey and the DEM (chapter 3) have been used to prepare cross section (figure 5.4) and longitudinal section (figure 5.5) of SY nala.

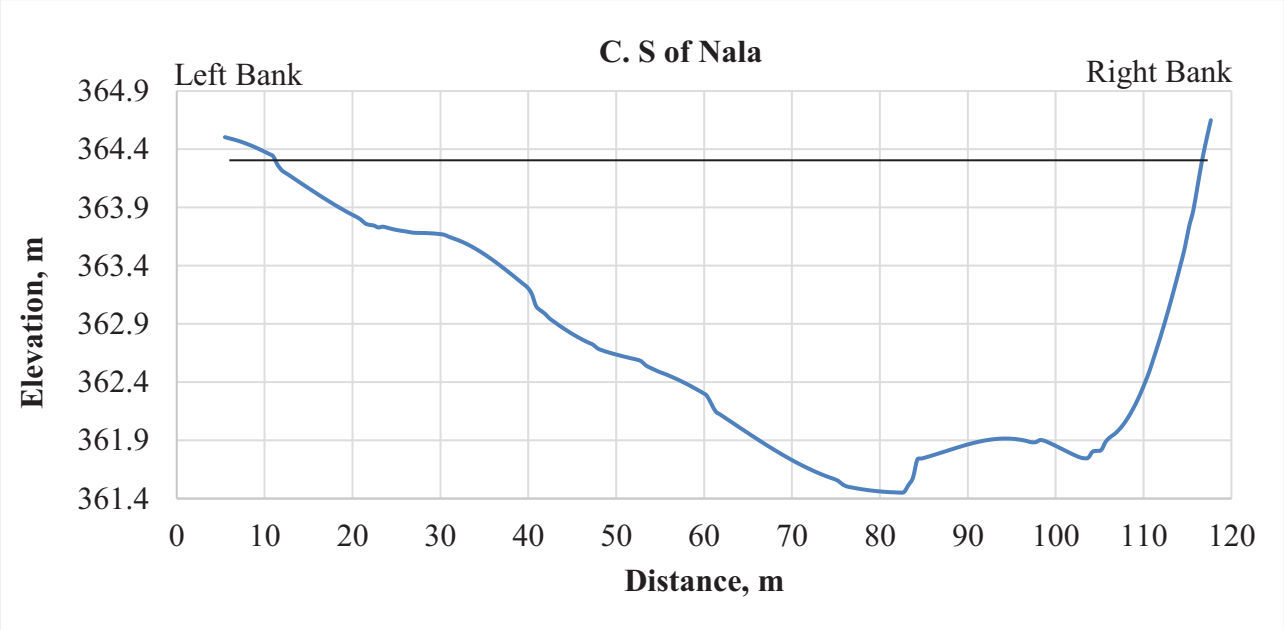


Figure 5.4: Cross section of SY nala at location

Figure 5.5: L-Section of SY nala

5.4.2 Bankful Discharge Estimation Using Slope Area Method:

In order to assess the flooding, bankful discharge capacity of SY nala has been estimated using slope area method. For estimation of cross section parameters, approximate ground levels on the left and right banks have been worked out with the help of recent contour map of the plant area. The computations are given in table 6.2.

Velocity (V) has been estimated by Manning's equation

$$V(m/s) = \frac{1}{n} \times R^{2/3} \times S^{1/2}$$

$$Q(m^3/s) = A \times V$$

n : Manning roughness coefficient assumed to be 0.035 for small streams in plains with small boulders.

R : hydraulic mean depth (=A/P)

A (m^2) : Cross section area

P (m) : perimeter

S (m/m) : surface water slope assumed to be same as river bed slope

Q : discharge (m^3/s)

The cross section parameters and bankful discharge computations are shown in table 5.3.

Table 5.3: Bankful Discharge Calculation and Comparison with 100 Year Flood

Parameter	Unit	SY Nala
Bank Level	m	364.4
Cross Section Area (A)	m^2	187.50
Perimeter (P)	m	112.18
Hydraulic mean radius (R=A/P)	m	1.67
Length	m	1472.8
Slope (S)	m/m	0.01008
Manning's coefficient (n)	0.035	0.035
Velocity (V)=(1/n)x($R^{2/3}$)x($S^{1/2}$)	m/sec	4.03
Discharge (Q)=(V)x(A)	m^3/sec	757.07
100 year flood estimated using Regional Flood Frequency Model of CWC	m^3/sec	24.79

5.4.3 External Flooding in Pre Project Condition

As seen in table 5.3, bankful discharge of capacity of SY nala is significantly higher than estimated 100 year flood in this nala . Hence it is safe to conclude that flooding doesn't occur under pre project condition. During the field survey of the plant area villagers stated that flooding has never occurred in the area.

5.4.4 External Flooding in Post Project Condition

Existing land use and topography in the project area will get modified during post project condition. However, the net effect of changes in land use, land cover and topography in post project condition shall be negligible. The flood generated by storm rainfall is expected to be similar as for pre project condition for the reasons discussed below.

1. Sloping land shall be leveled increasing opportunity time for infiltration and thus reducing storm runoff.

2. Area occupied by ash dyke area shall be dyked to create a pond in which ash will be deposited. In normal condition water transported to ash dyke with ash slurry will be recirculated through ash water recirculation system. However, outlet shall be provided in the ash dyke for excess storm water flow from ash pond to natural drainage system.
3. Part of the plant and township area such as road, main plant area, township area etc will become less pervious. This will cause more storm runoff.
4. Infiltration in the green belt area shall increase and hence storm runoff shall reduce.

Thus, the net effect of above mentioned changes in land use, land cover and topography shall be that the flood generated by storm rainfall in the catchments in post project condition are same as estimated for pre project condition.

5.4.5 Realignment of SY Nala

As stated earlier, SY nala passes through plant area and has entire catchment inside the plant area. The SY nala is proposed to be diverted and realigned in west- east direction between the existing switch yard and proposed main plant area. Layout and design channel capacity of the realigned Gangai nala are discussed in the next chapter.

5.5 BANK PROTECTION FOR EXISTING DRAINS

Carrying capacity of a) Nalkari river (in the reach along the project boundary), b)entire length of realigned SY nala, c)Tilaiyatar nala in downstream of ash dyke-II and d)Purnatoli nala in downstream of ash dyke-I shall have to be maintained. Following measures are recommended:

a. No encroachment be allowed in the flood plain of these drains.

b. These drains are likely to become convenient sinks (though undesirable) for disposal of solid wastes in the post project condition. This will have to be monitored and measures be taken to maintain flow capacity of these drains.

CHAPTER 6

INTERNAL DRAINAGE AND REALIGNMENT OF SY NALA

6.1 PARTITION OF PLANT AREA AND DESIGN CONSIDERATIONS

6.1.1 Area of Major Facilities

The plant components have been located on different ground formation levels by NTPC to economize the cost of earth work. The proposed formation levels are 372 m, 377 m, 378 m and 382 m. The DEM (chapter 3) can be used to identify areas requiring cutting and filling and to estimate the volume of earthworks required to level the undulating topography of the study area. Due consideration has been given to the existing slope of project area towards Nalkari river in deciding the layout of internal drainage. The area allocated for major facilities are given in table 6.1. The location of various facilities/plant components is shown in Figure 6.1.

Table 6.1: Area of Major Plant Facilities for PSTPP Phase-I

System/ Facility	Gross Area	
	(acre)	(hectare)
Township-I Area	7.5	3.04
Township-II Area	10.0	4.05
Main Plant Area	155.0	62.73
Switch Yard	35.0	14.16
New Transmission line corridor	7.5	3.04
Water Treatment Plant ,ACW CT, CPU REGN	20.0	8.09
Coal stock piles, wind barrier, lime stone storage shed, Part of ash pipe corridor	60.0	24.28
Railway track	180.0	72.85
Green belt	55.0	22.26
Total PSTPP Phase-I Area	530.0	214.5
Ash pond –I Area	400.0	161.88
Ash pond-II Area	300.0	121.41
Total ash dyke area	700.0	283.3
Total PSTPP Phase-I Area and ash dyke area	1230	497.8

Note: 1.As per PFR about 1234 acre is envisaged for PSTPP Phase-I plant, ash pond and railway siding

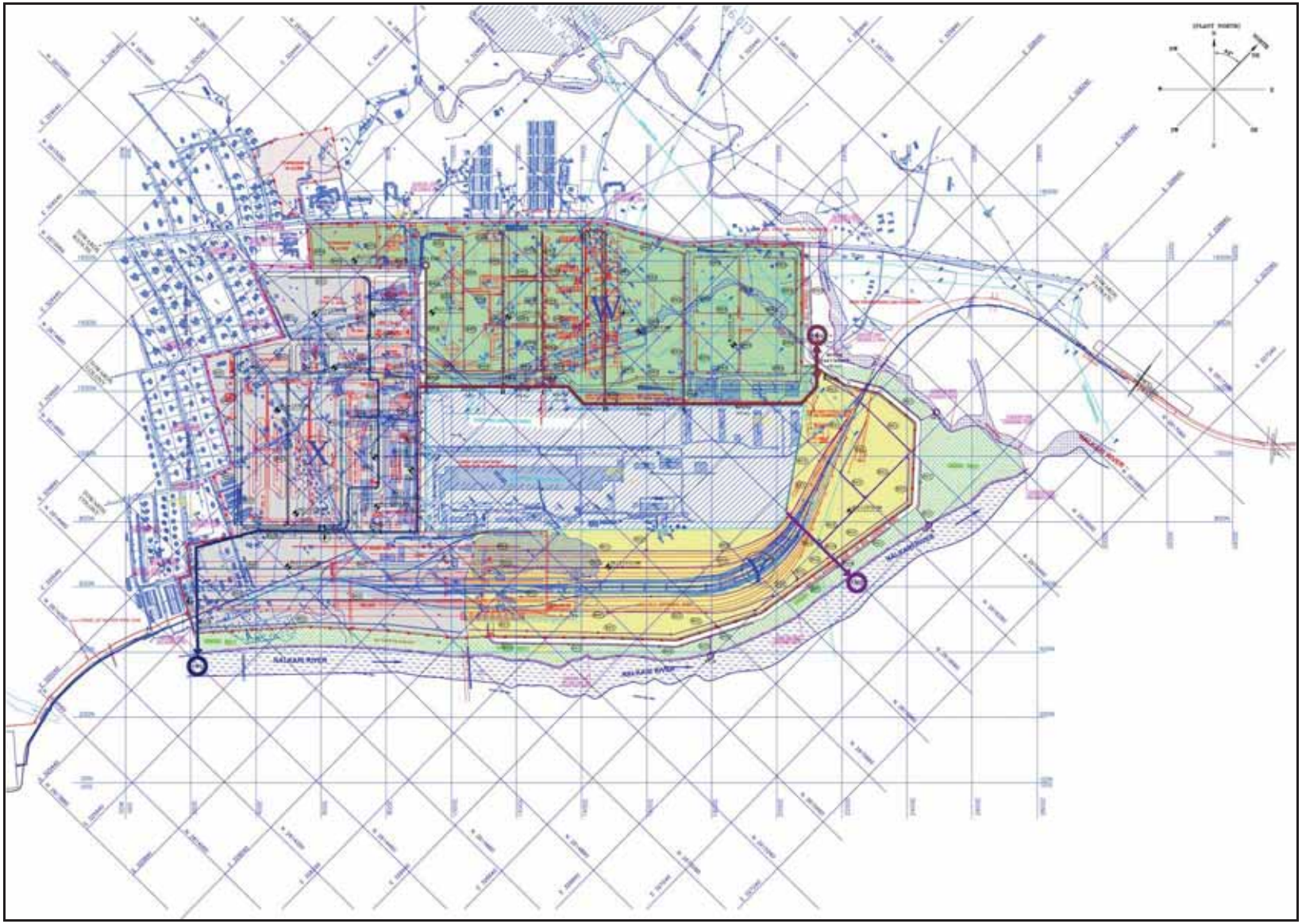


Figure 6.1 Location of various facilities (components) in the PSTPP Phase-I and existing plant

6.1.2 Partition of Project Area into Drainage Zones

In pre project condition, storm runoff from project site drains into following nalas;

Nalkari river: site of crushed coal stock pile area between existing township and existing switch yard and existing plant; site of proposed rail track, green belt area

SY Drain: Site of the proposed main plant area, switch yard, site of proposed township-I

Tilaiyatar nala: Site of township-II, area in vicinity of ash pond-II, spill of ash dyke-II

Purnatoli nala: Spill of ash dyke-I area

During the post project condition, three outfalls (OF1,OF2,OF3,) are envisaged for drainage of township, plant area and rail track area .Accordingly, the area is partitioned into three zones such that storm runoff from each of the zone is carried separately to the outfall OF1 on Tilaiyatar nala (through realigned SY nala) and to outfall OF2 and outfall OF3 on Nalkari river . The SY nala is proposed to be diverted and realigned in west- east direction between the existing switch yard and proposed main plant area. The diverted nala will consist of RCC rectangular channel. Thus the cost of internal drainage can be economized and coal area sewage is also kept separate from plant area sewage. Figure 6.2 and Table 6.2 show the partition of project area into W, X, Y, zones and drainage plan with three outfalls.

W Zone: It includes township-I area, switch yard, main plant area and any vacant land between Patratu – Ranchi road. The storm runoff shall be carried by realigned SY nala which has Outlet OF1 on end channel of original SY nala just upstream of confluence with Tilaiyatar nala. The storm runoff from existing plant area is also proposed to be carried by realigned SY nala.

X Zone: It includes administration building area, WTP area, workshop, ZLD for FGD, temp gypsum storage, crushed coal stock pile area, wind barrier for coal stock yard, part of rail track and other area occupied by misc facilities. Location of Outlet OF2 for zone X will be on Nalkari river. Depending on whether combined or separate sewage and sewerage system are planned, the storm runoff from coal yard area can be separated and storm runoff is carried to another outfall adjacent to OF2.

Y Zone: It mainly includes Railway track area and open land between a)existing main plant upto Nalkari river bank and b)open land on east side between existing plant and boundary of proposed plant . Outfall (OF3) for this zone is located on Nalkari river.

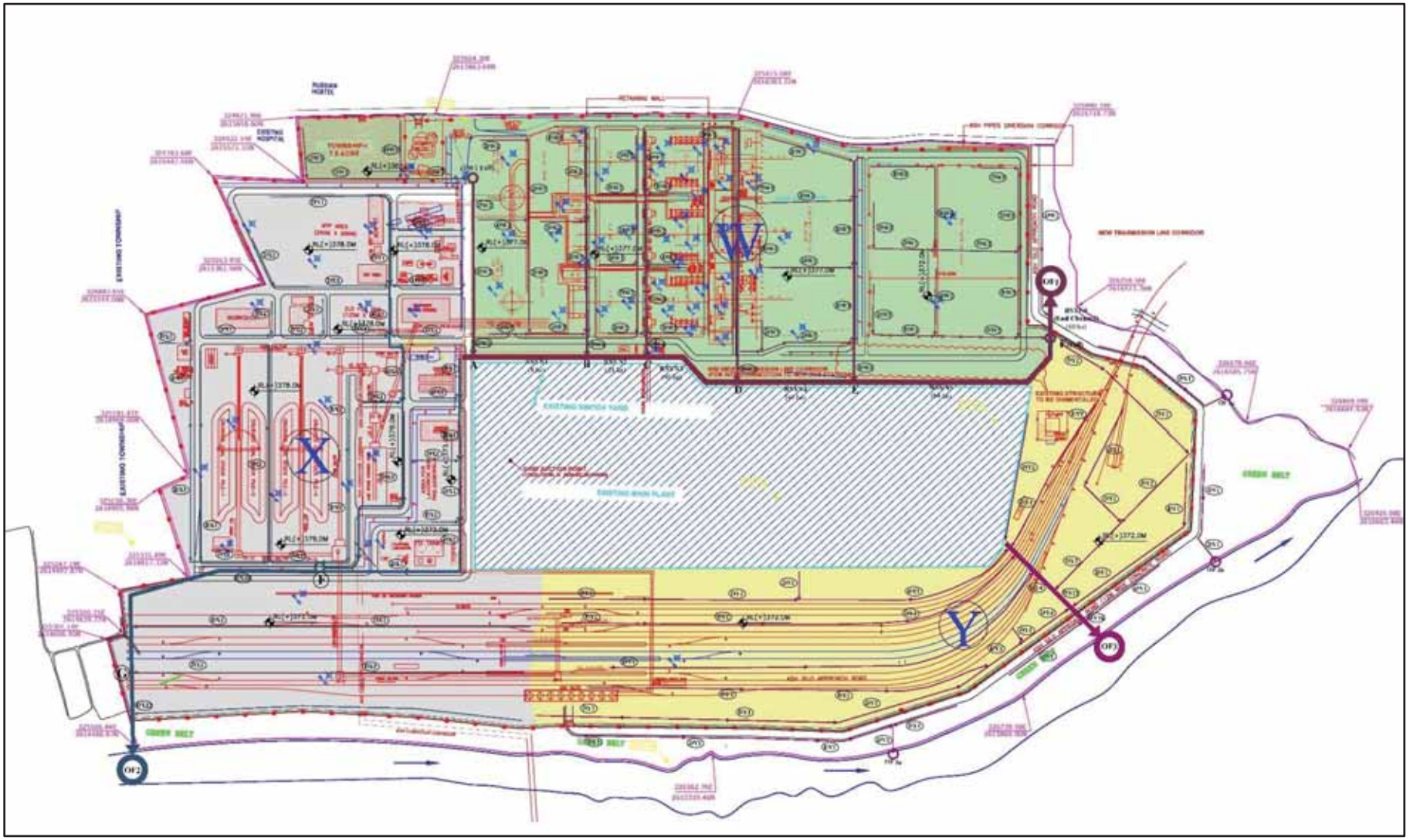


Figure 6.2 Partition of Plant Area in Three Zones, Drains and Outfall Locations

W zone also includes 12 m wide ash silo approach road which is located along the green belt. Storm water runoff from this road and adjoining area can be separately drained into Nalkari River at outfalls OF3a, OF3b and OF3c.

Z1 Zone: Excess storm water from Ash Pond-1 shall be drained to Purnatoli nala for safety of Ash Dyke. An ungated spillway shall be provided to spill the excess storm runoff.

Z2 Zone: Excess storm water from Ash Pond-II shall be drained to Tilaiyatar nala for safety of ash dyke.

Partitioning of area and provision of separate outfalls for different zones helps in reducing size of drains and hence cost of land.

Table 6.2: Partition of Project Area into Drainage Zones

Zone	Project Facilities	Runoff contributing area (acre)	Runoff contributing area (ha)	Outfall Location	Natural Drain
W	Township-I area, Administration building area, switch yard, main plant area and any vacant land between Patratu – Ranchi road and the realigned SY nala	190	76.9	OF1	end channel of original SY nala/ Tilaiyatar nala
X	WTP area, workshop, ZLD for FGD, temp gypsum storage, crushed coal stock pile area, wind barrier for coal stock yard, part of rail track and other area occupied by miscellaneous facilities	119	48.2	OF2	Nalkari river
Y	Railway track area and a)open land between existing main plant upto Nalkari river bank and b) open land on east side between existing plant and boundary of proposed plant. Ash silo approach road	156	63.1	OF3	Nalkari river
Z1	Ash Pond-1	400.0	161.9		Purnatoli nala
Z2	Ash Pond-II, township-II	300.0+10	121.4+4.1		Tilaiyatar nala

See also figure 6.2.

Green belt is in the form of strip along the Nalkari River. Rainwater in the green belt shall not be drained. Instead it will contribute to recharge of ground water. This will improve lean season flow in Nalkari River.

6.1.3 Design Considerations

The drainage layout has been planned based on following considerations:

(i) Drainage channels inside the plant area should safely carry storm runoff caused by design storm of 25 year return period as per norms specified by NTPC.

(ii) The realigned SY nala (RSYN) along plant boundary shall also be designed to safely carry 25year flood. It does not have catchment outside the plant area so there shall be no external flooding. Therefore it need not be designed for 100 year flood. RCC rectangular channel section is proposed for the RSYN. **It shall have sufficient capacity to carry storm runoff of the existing plant area also in addition to storm runoff from W zone.**

(iii) Bed slope of drains is to be kept such that flow is carried with sufficient velocity so that silting does not occur in channels and also so that channel invert levels are not in deep cutting.

(iv) Drains and culverts (under the railway track) will have concrete lined rectangular section.

(v) Width of drains shall not be less than 0.75 m considering cleaning by mechanical means.

(vi)Vertical falls shall be provided to negotiate difference in formation levels of various components in W zone and in X zone.

(a)In W zone from FGL 382.0 m (township and admn building area) to 377.0 m(plant area) ; from 377.0 m(main plant components) to 372.0 m along realigned SY nala and from 372.0 m(switch yard area) to realigned SY nala and from plant facilities to realigned SY nala).

(b) In X zone from FGL 378.0 m(WTP, ZLD, Coal stock pile area) to FGL 372.0 m rail track area

(c) In Y zone, floor of the end channel connected to outfall OF-3 is depressed by 1 m to avoid backwater in upstream channels.

Well type fall (also called cylinder fall) is suitable and economical.. The water is dropped into a well over a crest from where it emerges near the bottom dissipating its energy in turbulence inside the well.

(v) Channel slope, length, bed width are worked out such that capacity utilization in each of the channel segment (ratio of discharge contributed by connecting sub-catchments to the channel carrying capacity) is near to 1.0. However, in few channel segments this requirement may have to be compromised based on hydraulic and drainage layout considerations.

6.2 DESIGN DISCHARGE

6.2.1 Design Discharge for Internal Drainage

Existing land use and topography in the project area will get modified during post project condition. However, the net effect of changes in land use, land cover and topography in post project condition shall be negligible. The flood generated by storm rainfall is expected to be same as for pre project condition for the reasons discussed below.

1. Sloping land shall be leveled increasing opportunity time for infiltration and thus reducing storm runoff.
2. Area occupied by ash dyke area shall be dyked to create a pond in which ash will be deposited. In normal condition water transported to ash dyke with ash slurry will be recirculated through ash water recirculation system. However, outlet shall be provided in the ash dyke for excess storm water flow from ash pond to natural drainage system.
3. Part of the plant and township area such as road, main plant area, township area etc. will become less pervious. This will cause more storm runoff.
4. Infiltration in the green belt area shall increase and hence storm runoff shall reduce.

Thus, the net effect of above mentioned changes in land use, land cover and topography shall be that the flood generated by storm rainfall in the catchments in post project condition are same as estimated for pre project condition.

As per NTPC norms, internal drains are to be designed to safely carry 25 year flood so as to economize the cost of construction, maintenance and cost of land which shall be occupied by the drains. The 25 year flood estimate in SY nala has been explained in chapter 5. The 25 year flood estimate in SY nala and discharge per unit area are given in Table 6.3 below.

Table 6.3: Estimated 25 year flood in the SY nala

Natural drain	Location	25 Year Flood (cumec)	Catchment Area (sq km)	Discharge per sq km (cumec/sq km)	Discharge per ha (cumec/ha)
SY Nala	Eastern boundary of switch yard	11.7	77 ha	15.2	0.152

Design Discharge for Zone W: Discharge per unit area (specific discharge) is 0.152 cumec per hectare. Area of W zone is 76.9 ha. Internal drains in the plant area can be designed based on specific discharge of 0.152 cumec per hectare.However end channel is designed for runoff from 80 ha of W zone and 48 ha from the existing plant area. Therefore design flood discharge for end channel and outlet is 19.5 cumec. Outfall channel should have the capacity to carry 19.5 cumecs.

Design Discharge for Zone X: Discharge per unit area (specific discharge) is 0.152 cumec per hectare. Area of zone X is 48.2 ha .Design flood discharge from plant area is 7.33 cumec. Internal drains in the plant area can be designed based on specific discharge of 0.152 cumec per hectare.

Design Discharge for Zone Y: Discharge per unit area (specific discharge) is 0.152 cumec per hectare. Zone Y has an area of 63.1 ha. The flood discharge at out fall for this zone is 9.6 cumec. Outfall channel at OF3 should have the capacity to carry 10.0 cumecs.

6.2.2 Design Discharge for the Realigned SY nala

Entire catchment of SY nala lies within are of township-I and plant area. The nala is replaced by an RCC rectangular channel along plant boundary in west-east direction. It receives storm water from township and parts of main plant area(W zone) and parts of existing plant at different points along the channel. Therefore its cross section is increased in steps to accommodate flow contribution from various parts of W zone and existing plant.

Design Discharge of Spillway of Ash Pond I and Ash Pond II:

For preliminary planning, design discharge is worked out as below.

Area of Ash Pond I is 161.9 ha (400 acre). Discharge per unit area is assumed to be 0.152 m^3/sec/ha. So the design discharge is 24.6 m^3/sec. The ungated spillway should have sufficient length to spill 24.6 m^3/sec.

Ash Pond II: Area of ash pond is 121.4 ha (300 acres).So design discharge will be 18.45m^3/sec.

During the detailed design stage, reservoir flood routing with design storm as input should be carried out to fix the spillway capacity. Also, it is suggested to carry out ash dyke breach simulation study as has been carried out by NTPC for other projects.

6.3 CARRYING CAPACITY AND DESIGN OF CHANNEL SECTIONS

6.3.1 Carrying Capacity of Channel Segments

It is not necessary that a long drain should have same discharge carrying capacity over its length to carry the entire discharge generated from its catchment. For example all channel segments in in main plant area need not have same carrying capacity. In order to economize the cost and area occupied by drains, a suitable number of channel segments may be considered. An unit length of approximately 200 m has been considered for a channel segment and its own contributing catchment is taken to be about 4 hectare (200m × 200m).Discharge contributed by catchment of a channel segment is added to the capacity of its upstream channel segment(s) to estimate carrying capacity of the particular channel segment. Figure 6.2 shows the layout of drains in different zones. Size of different channel segments in zone W, X, and Y are stated in table 6.4, table 6.5 and table 6.6 respectively. Figure 6.3, Figure 6.4 and Figure 6.5show layout of channel segments in zone W,X,Y respectively. **Carrying capacity of different channel segments of the Realigned SY nala (RSYN) are stated in table 6.4. It is master drainage channel of W zone .It is designed to carry storm runoff from W zone and from existing plant area.**

6.3.2 Channel Sections for Internal Drainage and Realigned SY Nala

Design of drainage channel depends on site specific properties (topography, soil characteristics etc.) which will change in post project condition .Internal drainage channels as well as the realigned SY nala (RSYN) are designed as rectangular open channel to take discharge from assigned drainage areas. Manning's roughness coefficient is taken for concrete channel (0.016).

Bed Slope: Internal drainage channels in W,X,Y zones will have bed slope of 1:1000 i.e.1m/km or 0.001.However, the last two channels(end channel and preceding channel) in each zone will be laid at 1;500 slope(s=0.002) as sufficient natural gradient is available. This will reduce size and hence capital cost of drain.

The RSYN is considered as master drain of W zone. Natural slope of original SY nala is 10.08 m/km=0.01008 m/m =1.008%). It is a steep slope as the region is hilly area. Original length of nala is 1.4728 km. The initial bed level of realigned SY nala is kept at 375.5m and it is proposed to lay the realigned nala on a slope of 1:500 i.e.1m/500 m or 0.002.

Specific design discharge is taken as 0.152 cumec.

For the depth of channel section, a resistance formula proposed by Robert Manning for uniform flow in open channel is used.

$$V(m/s) = \frac{1}{n} \times R^{2/3} \times S^{1/2};\ R = A/P$$

Q=AxV

where:

- V is the velocity (m/s),
- S is the slope of channel = h_L/L
- R is hydraulic mean depth (=A/P)
- A is cross section area (m^2)
- P is perimeter (m) and,
- n is Manning's roughness coefficient (=0.016 for concrete lined channel).
- Q is the discharge (m^3/sec)

For rectangular section

A= B×D

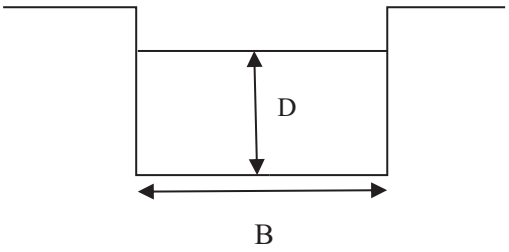
P=B+2D

R=A/P=(B×D)/(B+2D)

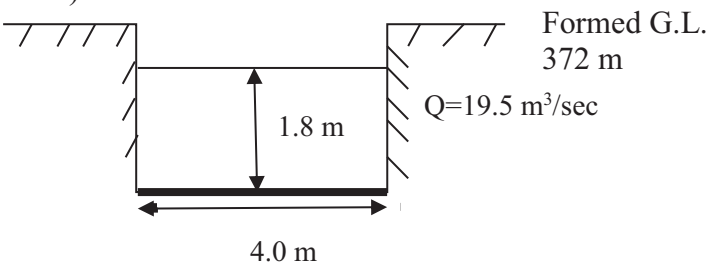
And section factor $\frac{Q_n}{\sqrt{S}} = AR^{2/3} = \frac{(B \times D)^{5/3}}{(B+2D)^{2/3}}$

For given Q, n, s the width and depth of the channel are adjusted so that above equation is satisfied. Depth of flow is constraint by the invert level of outfall and the FGL of the contributing catchment area.

To carry maximum flow through a given cross section area, depth of flow (D) should be near about half of the width (B) of section.



A typical section of the lined rectangular channel (end channel of realigned SY nala(RSYN6)) is shown below(see table 6.4).



Slope is 1:500(1m/500m)

Table 6.4: Design of Channel Sections and the realigned SY nala (RSYN) in W zone

Channel name	Catchment area W zone (ha)	Catchment area old plant (ha)	Carrying Capacity Q (cumec)	Manning n	Slope S 1:1000	Section Factor $Qn/\sqrt{S}$	Bed Width B (m)	Depth D (m)
DW1	4	-	0.608	0.016	0.001	0.308	1.00	0.70
DW2	8	-	1.22	0.016	0.001	0.617	1.55	0.75
DW3	12	-	1.82	0.016	0.001	0.921	1.75	0.90
DW4	16	-	2.43	0.016	0.001	1.229	1.95	1.00
RSYN1	8	8	2.43	0.016	0.002	0.869	1.95	0.9
RSYN2	24	16	6.08	0.016	0.002	2.175	2.6	1.15
RSYN3	40	24	9.73	0.016	0.002	3.481	3.0	1.4
RSYN4	48	32	12.2	0.016	0.002	4.365	3.4	1.5
RSYN5	64	48	17.0	0.016	0.002	6.082	3.8	1.7
RSYN6	80	48	19.5	0.016	0.002	6.977	4.0	1.8

Table 6.5: Design of Channel Sections in X zone

Channel name	Catchment area (ha)	Carrying Capacity Q (cumec)	Manning n	Slope S 1:1000	Section Factor $Qn/\sqrt{S}$	Bed Width B (m)	Depth D (m)
DX1	4	0.608	0.016	0.001	0.308	0.95	0.75
DX2	8	1.22	0.016	0.001	0.617	1.45	0.80
DX3	12	1.82	0.016	0.001	0.921	1.75	0.90
DX4	16	2.43	0.016	0.001	1.229	2.15	0.90
DX5	20	3.04	0.016	0.001	1.538	2.35	1.00
DX10	40	6.08	0.016	0.002	2.175	2.50	1.20
DXEND(DX12)	48.2	7.5	0.016	0.002	2.683	2.95	1.20

Table 6.6: Design of Channel Sections in Y zone

Channel name	Catchment area (ha)	Carrying Capacity (cumec)	Manning n	Slope S 1:1000	Section Factor $Qn/\sqrt{S}$	Bed Width B (m)	Depth D (m)
DY1	4	0.608	0.016	0.001	0.308	0.95	0.75
DY2	8	1.22	0.016	0.001	0.617	1.45	0.80
DY3	12	1.82	0.016	0.001	0.921	1.75	0.90
DY4	16	2.43	0.016	0.001	1.229	2.15	0.90
DY7	28	4.26	0.016	0.001	2.155	3.00	1.00
DY11	44	6.69	0.016	0.002	2.393	3.30	1.00
DYEND (DY16)	64	10.0	0.016	0.002	3.578	3.70	1.20

6.4 VERTICAL FALLS ON CHANNELS

In addition to the three outfalls (OF1, OF2, OF3), vertical falls on some channel segments are also required. Plant components in W zone are at different FGL (382 m, 377 m, and 372 m). Similarly plant components in X zone are at different FGL (378 m and 372 m). Therefore, vertical falls are necessary to negotiate difference in bed level of connecting channels.

Well type fall (also called cylinder fall) is suitable and economical for large height fall and small discharge. The water is dropped into a well over a crest from where it emerges near the bottom

dissipating its energy in turbulence inside the well. For low height fall and large discharge, crest weir over full width of channel is suitable.

(i) In W zone, township and administration building area are at FGL 382.0 m whereas main plant area is at FGL 377.0 m (fall of 5.0m) and switch yard area is at FGL 372.0 m. The initial bed level of realigned SY nala is kept at 375.5m and slope is 1:500(2m in 1000m).

(ii) In X zone, WTP, ZLD, Coal stock pile area are at FGL 378.0m whereas rail track area is at FGL 372.0m(fall of 6.0 m).

(iii) In Y zone, a drop of 1 m is proposed at beginning of end channel so that accumulation of flow from lateral channels does not cause backwater in upper channels.1m drop is possible as bank level of Nalkari river at location of outfall OF-3 is sufficiently lower.

Location of vertical falls in W zone, X zone and Y zone are shown in figure 6.3 ,6.4 and 6.5 respectively. Location and size of vertical falls in W , X and Y zone are given in table 6.7 , 6.8 and table 6.9 respectively.

Table 6.7: Location and size of vertical falls in W zone

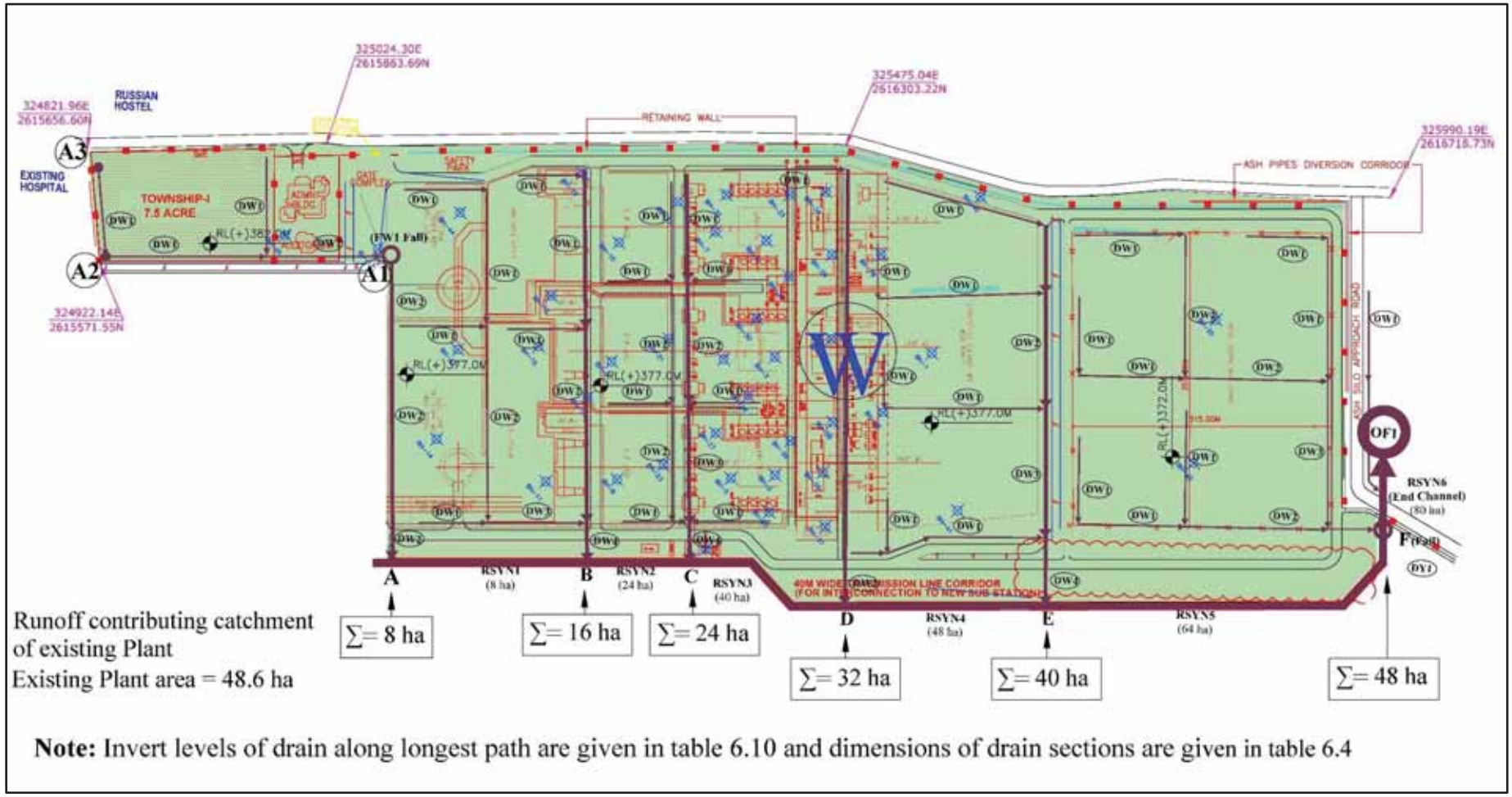
Zone	**Channel**	**Location in figure 6.3**	**Drop Height (m)**	**Discharge (cumec)**	**Fall type**	**Size**
W	DW2	FW1	5	1.2	well	0.5m dia
	DW2	A	1.5	1.2	crest weir	1.55m width
	DW4	B	1.5	2.43	crest weir	1.95m width
	DW4	C	1.5	2.43	crest weir	1.95m width
	DW2	D	1.5	1.2	crest weir	1.55m width
	DW4	E	1.5	2.43	crest weir	1.95m width
	Dw4	F	2.0		crest weir	1.95m width

Table 6.8: Location and size of vertical falls in X zone

Zone	Channel	Location in figure 6.4	Drop Height (m)	Discharge (cumec)	Fall type	Size
Z	DX2	FX1	6	1.2	well	0.5m dia
	DX5	FX1	6	3.04	Crest weir	2.35m width

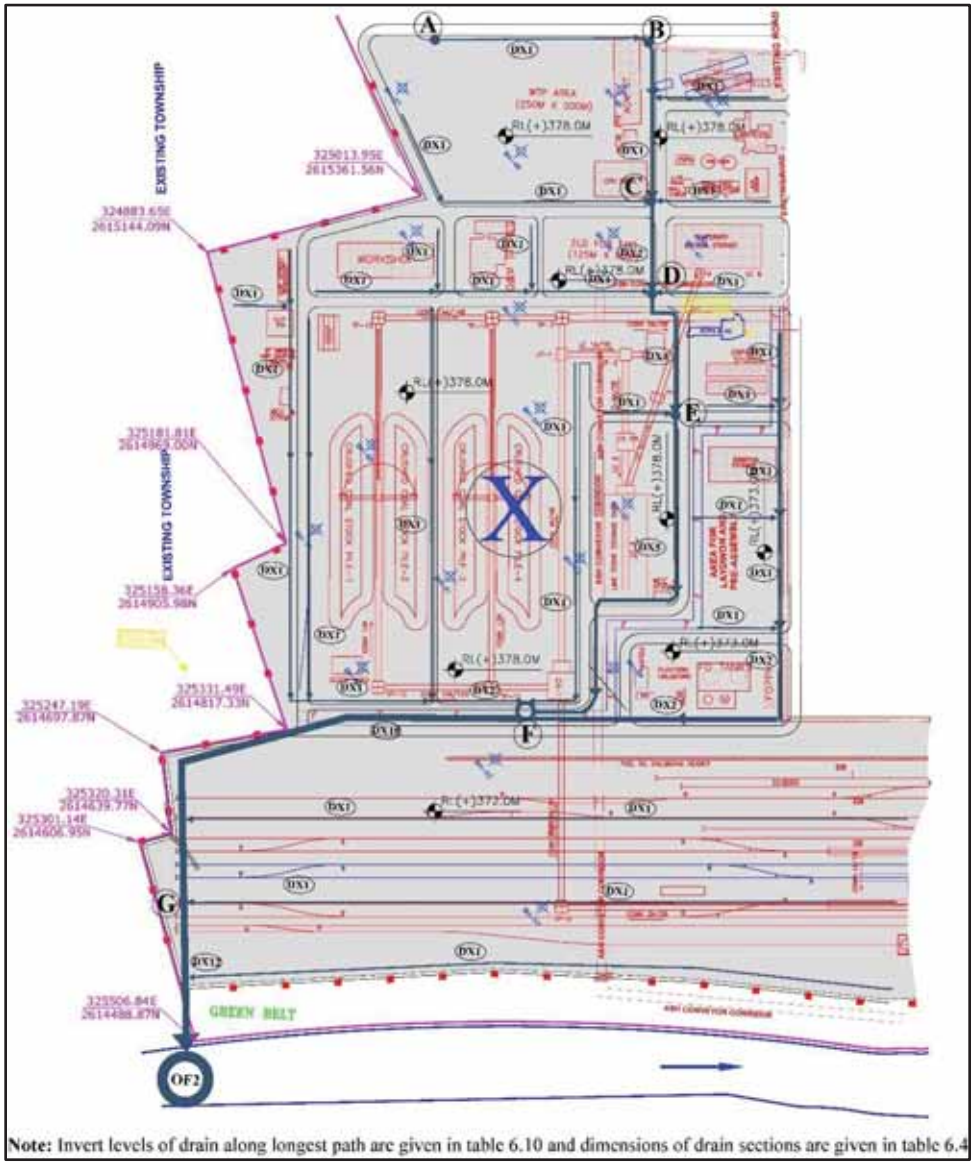
Table 6.9: Location and size of vertical fall in Y zone

Zone	Channel	Location in figure 6.5	Drop Height (m)	Discharge (cumec)	Fall type	Size
Y	DY16	FY1	1.0	10.0	Crest weir	3.7 m width



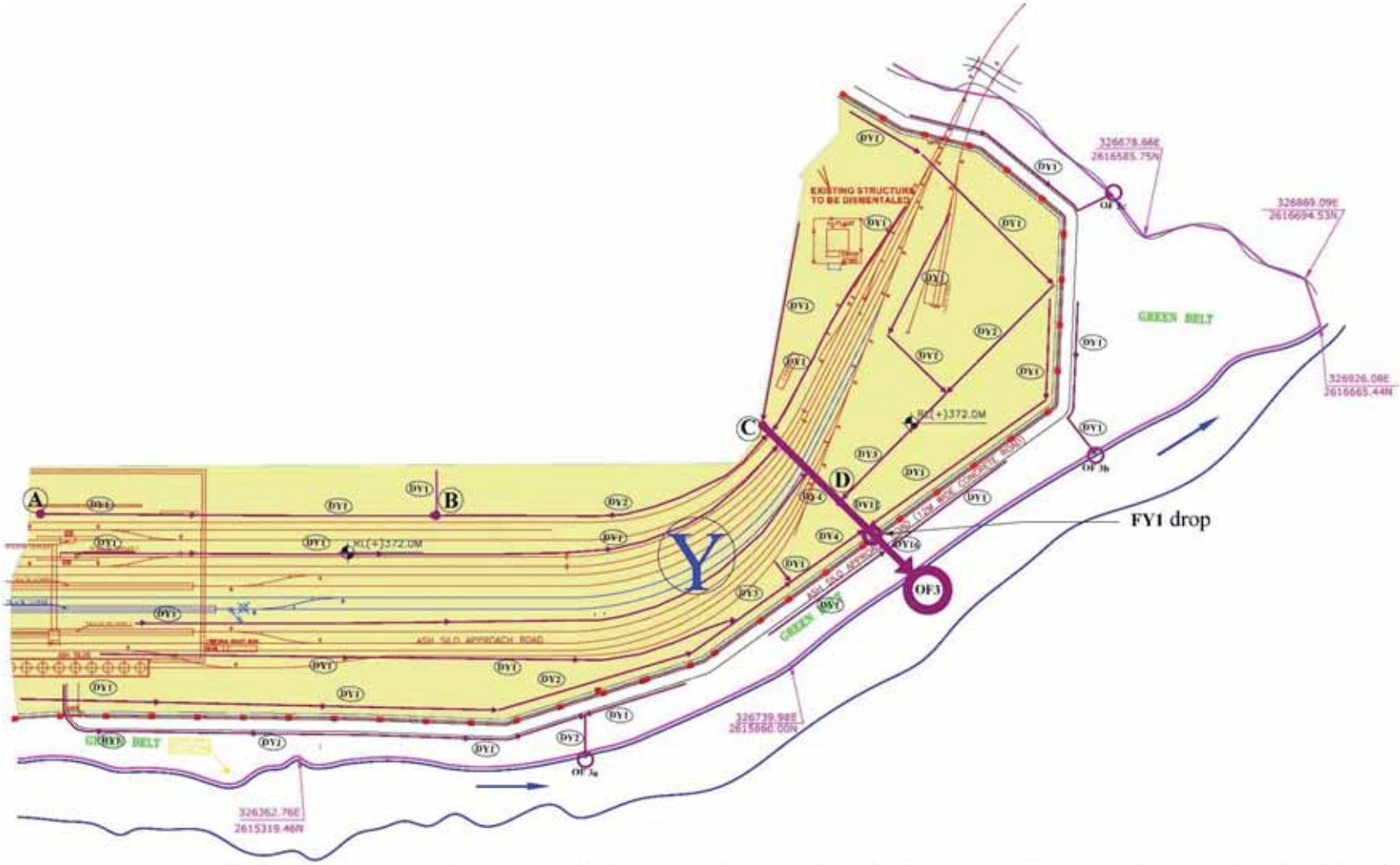
Note: Invert levels of drain along longest path are given in table 6.10 and dimensions of drain sections are given in table 6.4

Figure 6.3 Drainage Plan Showing Plant Area Drains, Longest Flow Path and Outfall Location (FW1, F) in W Zone



Note: Invert levels of drain along longest path are given in table 6.10 and dimensions of drain sections are given in table 6.4

Figure 6.4 Drainage Plan Showing Plant Area Drains, Longest Flow Path and Outfall Location (FX1) in X Zone



Note: Invert levels of drain along longest path A-B-C-D-OF3 are given in table 6.12 and dimensions of drain sections are given in table 6.6

Figure 6.5 Drainage Plan Showing Plant Area Drains, Longest Flow Path and Outfall Location in Y Zone

6.5 INVERT LEVELS OF CHANNELS LYING ON LONGEST FLOW PATH

Longest flow path is the path followed by gravity flow from farthest point of drain to outfall. Invert levels of channel segments lying on the longest path will help to lay the main drain on desired slope and to adjust layout of the lateral channels at junctions. Lateral channels at junction point with the main drain(on longest path) shall have invert level of end node equal to or higher than the invert level of end node of the channel segment on main drain. Longest flow path in W, X, Y zones are shown in figures 6.3, 6.4 and, 6.5 respectively. Tables 6.10, 6.11 and 6.12 show the computation of invert levels in different channel segments.

Table 6.10: Invert Levels of Channels along Longest Flow Path(Main Drain) in W Zone

Channel Segment(ref Figure 6.3)	Length(m)	Slope	Drop in bed level(m)	Invert Level(m)		FGL of surrounding area(m)	Depth of flow in Channel(m)	FSL of flow in channel(m)
				Initial node	End node			
A3-A2	100	0.001	0.1	381	380.9	382	0.7	381.7
A2-A1	200	0.001	0.2	380.9	380.7	382	0.7	381.6
				Drop of 5 m				
A1-A	333	0.001	0.33	375.7	375.37	377	0.75	376.45
A-B	262	0.002	0.524	375.37	374.846	<377	0.8	376.17
B-C	126	0.002	0.252	374.846	374.594	<377	1.0	375.846
C-D	210	0.002	0.42	374.594	374.17	<377	1.1	375.694
D-E	244	0.002	0.488	374.17	373.686	<377	1.15	375.32
				Drop of 4m				
E-F	472	0.002	0.944	369.7	368.71	<372	1.2	370.9
F-OF1	98	0.002	0.196	368.71	368.51	<372	1.2	369.91

Table 6.11: Invert Levels of Channels along Longest Flow Path (Main Drain) in X Zone

Channel Segment(ref Figure 6.4)	Length(m)	Slope	Drop in bed level(m)	Invert Level(m)		FGL of surrounding area(m)	Depth of flow in Channel(m)	FSL of flow in channel(m)
				Initial node	End node			
A-B	267	0.001	0.267	377	376.733	378	0.75	377.75
B-C	200	0.001	0.2	376.733	376.533	378	0.75	377.48
C-D	100	0.001	0.1	376.533	376.43	378	0.8	377.33
D-E	164	0.001	0.164	376.43	376.266	378	0.9	377.33
E-F	508	0.001	0.508	376.266	375.758	378	1.0	377.266
				Drop of 6m				
F-G	133	0.002	0.266	369.75	369.484	372	1.2	370.95
G-OF2	207	0.002	0.414	369.484	369.07	372	1.2	370.68

Table 6.12: Invert Levels of Channels along Longest Flow Path (Main Drain) in Y Zone

Channel Segment(ref Figure 6.5)	Length(m)	Slope	Drop in bed level(m)	Invert Level(m)		FGL of surrounding area(m)	Depth of flow in Channel(m)	FSL of flow in channel(m)
				Initial node	End node			
A-B	750	0.001	0.75	371	370.25	372	0.75	371.75
B-C	750	0.001	0.75	370.25	369.5	372	0.8	371.05
C-D	258	0.001	0.258	369.5	369.242	372	0.9	370.4
D-E	51	0.002	0.102	369.242	369.14	372	1.0	370.24
				Drop of 1 m				
E-OF3	86	0.002	0.172	368.14	367.968	371	1.2	369.168

6.6 DRAINAGE OF ASH DYKE-1 AREA

Two ash dyke areas are available (figure 6.6). Approx. 400 acre of land is available at Dyke -1. The land is located about 3km from the plant boundary. Fly Ash (FA) from new units of Patratu STPP, Phase-I (3X800MW) was earlier proposed to be disposed off through High Concentration Slurry Disposal (HCSD) system and bottom ash (BA) in the form of lean slurry. However now it is envisaged to utilize Dyke -1 (about 400 acre) area for dry disposal of ash in mound form.

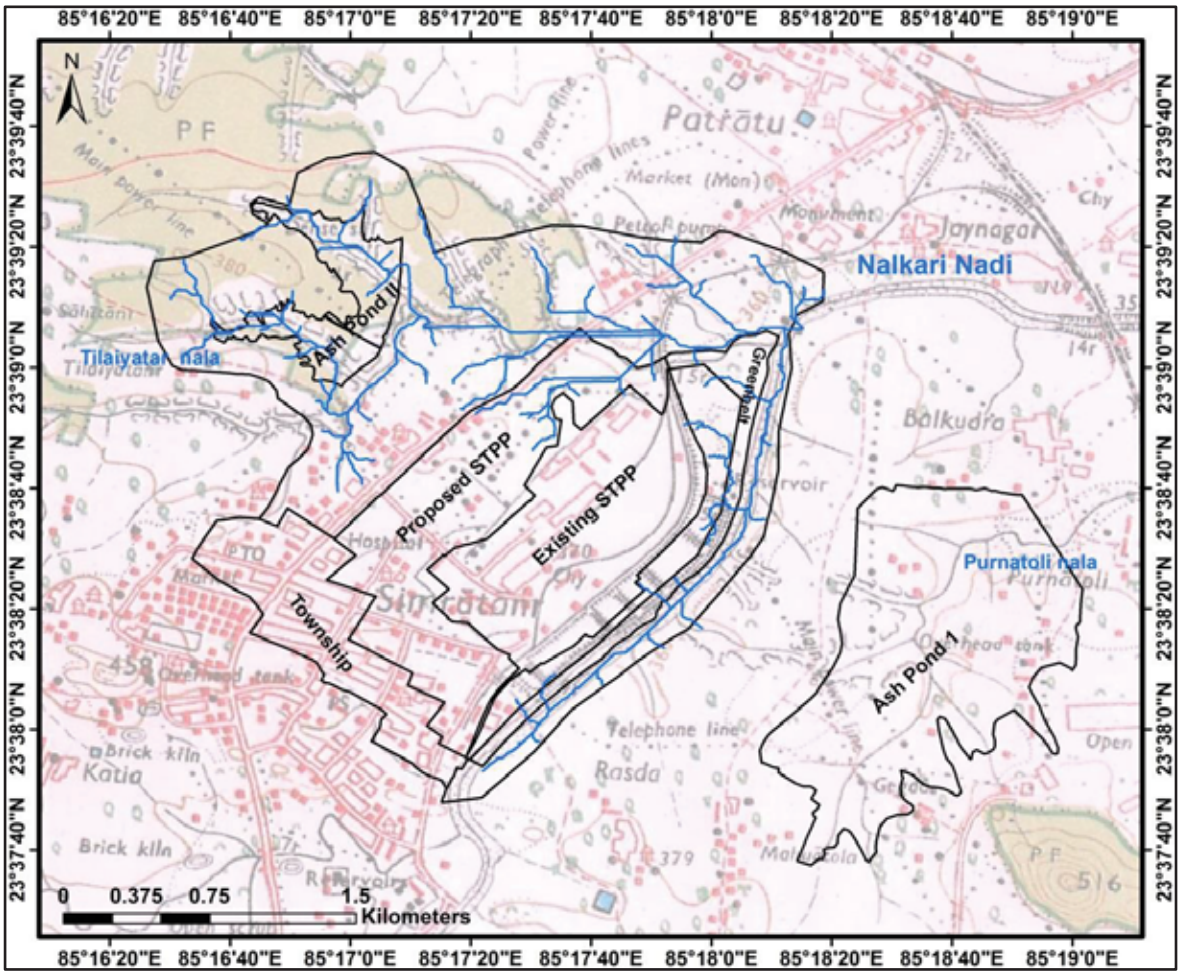


Figure 6.6: Location of ash dyke areas with reference to proposed STPP

Dry disposal scheme is in proposal stage and details regarding ash disposal scheme (spatial and temporal disposal of ash, design capacity of ash mound are being worked out by NTPC. Therefore, at present only design concept can be given.

Natural Drainage and Topography in Ash Dyke-1 Area: Figure 6.7 (same as figure 3.4b chapter 3) show the variation in elevation from 356 m to 391 m in the ash dyke-1 area. North-eastern part has lowest elevation of 356.0 m. The south-eastern part has highest elevation of 391 m.

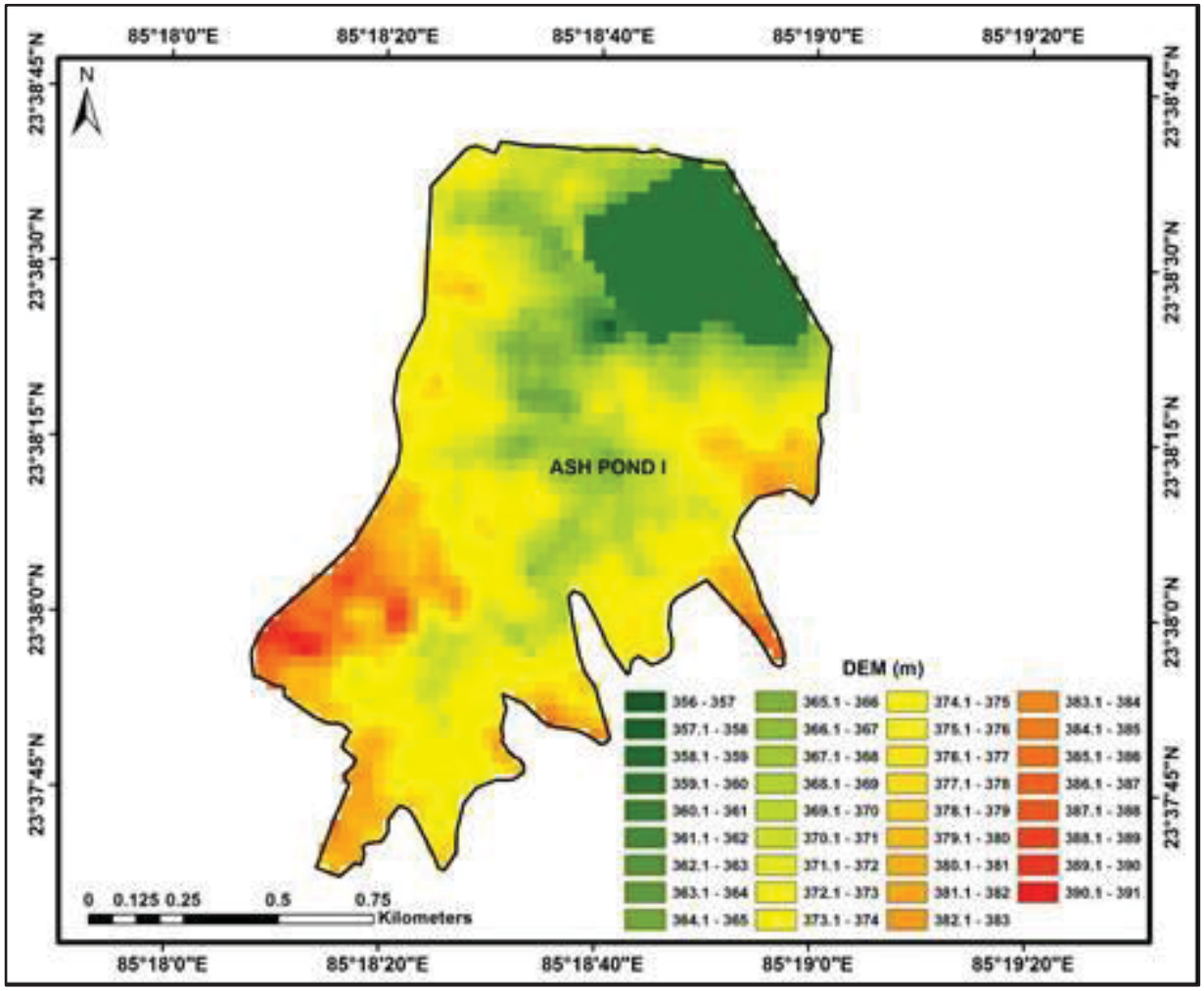


Figure 6.7: Topography of the Ash Dyke -1 Area

The ash dyke-1 area lies in catchment of Purnatoli nala. Tokisud-II coal block area is in upstream of ash duke-1 and it also lies in catchment of Purnatoli nala . Ash Dyke-I area lies on the right bank side of Nalkari river. The Purnatoli nala joins Nalkari river on its right bank.

Drainage Design Concept:

i)Low Height Peripheral Embankment: Though it is being referred to as ash dyke, in practice it is to be used as land fill and as ash mound area. The dyke area will have a 1 to 3 m high earthen embankment around it. Purpose of the peripheral embankment is not to create space for ash

deposit as in case of wet disposal but to prevent entry of storm runoff from small size natural drains surrounding in the dyke area The peripheral embankments can be designed using similar design parameters as for flood control earthen embankments.

ii) Drainage of Embankment Slopes and Blocked Drains on Periphery: A toe drain shall be provided on outer slope to drain storm runoff from embankment slope. The storm runoff from surrounding area which otherwise was entering the Purnatoli nala in dyke area will also be carried by this toe drain. The toe drain shall be trapezoidal in shape and unlined. It will carry storm runoff to Purnatoli nala in downstream of the dyke. **For detailed design of drainage of ash dyke embankment, code of Practice given in Bureau of Standards code IS: 9429: "Code of practice for drainage system for earth and rock filled dams" may be followed.**

iii). Ungated Spillway of Ash Dyke-1: Storm water from Ash dyke-1 area shall be drained to Purnatoli Nala. For safety of ash dyke an ungated spillway shall be provided to spill the excess storm runoff. For preliminary planning, design discharge is worked out as below.

Area of Ash Pond I is 161.9 ha (400 acre). Discharge per unit area is assumed to be 0.152 m^3/sec/ha. So the design discharge is 24.6 m^3/sec. The ungated spillway should have sufficient length to spill 24.6 m^3/sec.

iv) Treatment of Dry Ash Mounds:

a) A filter bed shall be provided at bottom of ash mound.

b) The dry ash is conditioned with water and a sprinkler system will be used to control dust emission.

c) The hillocks formed out of the consolidated ash will be landscaped with flora that survives on the relatively hostile terrain..

d) Grass will be planted on the slopes of the fly ash mound and polymer layering is done to prevent the ash from being blown by the wind. The ash mound eliminates leaching effect and has a separate system for storage of pulverized fly ash and furnace bottom ash. It facilitates large-scale utilisation at a later stage.

v) Drainage of Ash Mound: Creation of mound will result in steeper slope (1:4) than the natural slope of land(1:200 and less) occupied by ash mound. Infiltration capacity in the area will reduce. Steeper slope and reduced infiltration will result in higher runoff rate. Polymer layering

is necessary not only to prevent the ash from being blown by the wind but also for controlling rain water induced ash erosion and transport to Purnatoli nala .

vi) Example of Ash Mound at Dadri Plant: The power plant is first in the country to incorporate dry ash disposal technique The height of the ash mound in Dadri, constructed on 375 acres of land is 55 meters with a top surface area of 140 acres and having a side slope of 1:4 with a haulage road at 15 m interval. The ash mound has a capacity to store 53 million cubic meter of ash. The capacity of ash mound is sufficient for running 840 Mega Watt (MW) power for 40 years. The extraction and disposal of 180 tonnes of ash produced every hour in wet slurry condition would have required a huge land area for construction of an ash dyke.

6.7 DRAINAGE OF ASH DYKE-2 AREA

The Dyke-2 area (figure 6.8) of about 300acre is presently being used for disposal of ash from the existing units of Patratu Plant. It is also located about 3km from the plant, but on the diametrically opposite side of Dyke -1Presently, ash is being disposed in the form of lean slurry in Dyke-2 area.

Natural Drainage and Topography in Ash Dyke-2 Area: Figure 6.8 (same as figure 3.4a in chapter 3) show that the north eastern part of the Ash pond area has lowest elevation of 376 m. The North western part of the study area has highest elevation of 388 m. These elevations will provide a guideline for economizing the cost of earth work during the design of Ash pond.

The ash dyke-2 area lies in catchment of Tilaiyatar nala. : This nala carries storm runoff from site of township-II, area in vicinity of ash pond-II and from ash dyke-II area. The Tilaiyatar nala joins Nalkari River on its left bank.

Design Discharge of Spillway of Ash Dyke-2: Storm water from ash dyke-2 area shall be drained to Tilaiyatar nala. For safety of ash dyke, an ungated spillway shall be provided to spill the excess storm runoff. For preliminary planning, design discharge is worked out as below.

Area of ash dyke-2 area is 121.4 ha (300 acres).So design discharge will be 18.45m^3/sec. The ungated spillway should have sufficient length to spill 18.45 m^3/sec. During the detailed design stage, reservoir flood routing with design storm as input should be carried out to fix the spillway

capacity. Also, it is suggested to carry out ash dyke breach simulation study as has been carried out by NTPC for other projects.

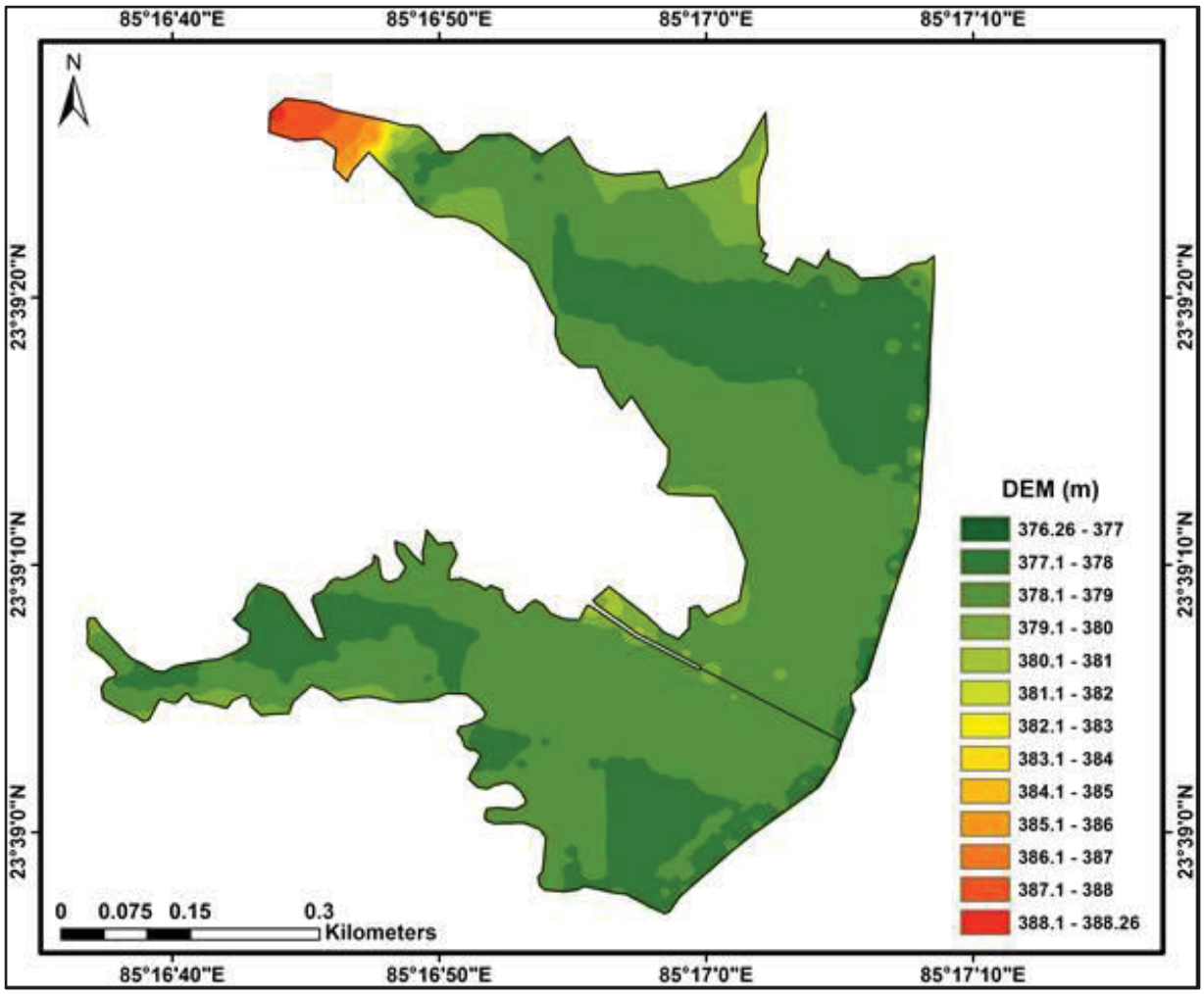


Figure 6.8: Topography of the Ash Dyke -2 Area

Annexure-4

5.42.00 **Flue Gas Desulphurization System**

5.42.01 **Limestone Storage Hopper, Underground TP's & Underground Tunnel**

Limestone storage Hopper, Underground portion of TP's and Underground Tunnel shall be of R. C. C. construction. Minimum thickness of R. C. C. raft at bottom shall be 600 mm. Minimum thickness of RCC side walls shall be 600 mm at bottom and 300 mm at top. Limestone storage hopper shall have structural steel shed covered with permanently colour coated profiled steel sheet.

The vertical and inclined portion of hopper shall be provided with 50 mm thick guniting (shotcreting). Details of shotcreting have been given elsewhere in this specification.

Expansion joints shall be provided at a maximum distance of 40m. 600 mm wide water stop fabricated with 22G copper plate with bitumen board fillers and polysulphide sealing compound as specified elsewhere shall be used as expansion joint material. Floor shall be provided with cross slope not flatter than 1 in 50 towards side drains. Side drains shall be sloped towards sump where sump pumps as specified elsewhere, shall be provided. The slope of side drains shall not be flatter than 1 in 400. Side drains and sump shall have removable type steel grating cover. Gratings shall be galvanized to grade 610 gm/m2.

Water proofing / Damp proofing of under ground hopper and tunnels, underground (i. e. basement) portion of transfer houses shall be done by providing the following treatments:

Chemical injection grouting for inner faces (details as specified elsewhere).

Polymer modified cementitious coating on earth side face as per the following:

On the outer surface of walls, frames and roof slabs coming in contact with earth, polymer modified cementitious coating in two layers as specified and as per manufacturer's specifications shall be provided directly on the concrete surface.

50 mm thick P. C. C. (1 : 2 : 4 with 10 mm nominal size stone aggregates) shall be provided under the raft i.e. over the lean concrete, followed by polymer modified cementitious coating in two layers (slurry mix application) as per manufacturer's specification. 50 mm thick P. C. C. (1 : 2 : 4) with 10 mm nominal size stone aggregates shall then be laid over the polymer modified cementitious coating before laying the raft.

Grade slab shall be provided for limestone storage hopper. Plinth protection along with drains shall be provided along the Hopper complex. 5m wide paving shall also be provided around machinery hatches.

Earth pressure to be considered for design shall be due to earth pressure at rest (Ko) condition only. Earth pressure due to surcharge intensity of Uniformly Distributed Load (U. D. L) of intensity 2 T / Sq. M. shall be considered in the design.

A minimum safety factor of 1.2 against uplift due to ground water shall be ensured during execution and after execution, considering dead weight of the structure to be 0.9 times only, ground water table at adjoining formation level and soil wedge angle of not more than 15 degrees.

Also, FOS against uplift, to be taken as 1.0, considering the dead wt. of structure and soil resting on side projections if any in the vertical plane. Inclined wedge action of soil shall not be considered in this case.

Wherever, slope of tunnel exceeds 10°, R. C. C. steps shall be provided for the entire width of each walkway.

5.42.02 Overhead / Ground Conveyor Galleries and Trestles

Overhead conveyors shall be located in a suitably enclosed gallery of structural steel. The overhead gallery shall consist of two vertical latticed girders having rigid jointed portal frame at both ends. Cross beams at floor level supporting conveyor stringer beams shall be made of single rolled steel beam or single channel section (ISMB or ISMC) or plate girder. Horizontal bracings are to be provided at top & bottom plan of the gallery (latticed girders shall be braced together in plan at the top and bottom). Common end portal frame shall not be used for adjacent conveyor spans. Roof truss shall be provided at upper node points of latticed girders to form an enclosure. The maximum span of overhead gallery shall be limited to 25 meters unless higher span is required due to site conditions, which shall be subject to approval of the Engineer. The gallery should as far as possible be erected as a box section keeping all the vertical and horizontal bracing tied in proper position. The gallery should be checked for all erection stresses that are likely to develop during handling and erection and if required, temporary strengthening of gallery members during erection shall be made. Contractor can also use tubular steel sections for roof truss of conveyor galleries only. All structures using tubular steel sections shall be shop-fabricated, shop painted and ready for erection at site.

Seal plates under the conveyor galleries shall be provided in such a way that complete gallery bottom shall form a leak proof floor.

The ground conveyors shall be located in suitably enclosed gallery of structural steel consisting of rigid portal frames spaced at regular intervals and suitably braced. Plinth protection along with drains shall be routed along the ground conveyors.

For double stream conveyor gallery, two side and one central walkway of width 800 mm and 1100 mm respectively shall be provided. The width of two side walkways for single stream conveyor gallery shall be 800 mm and 1100 mm respectively. Both sides of central and side walkways shall be provided with pipe handrails all along the conveyor gallery. Hand railing should not be supported on conveyor supporting stringers. The walkways shall be chequered plate construction with anti - skid arrangement. The anti - skid arrangement will consist of welding of 10 mm square steel bars at a maximum spacing of 500 mm along the length of the gallery. Where the slope of walkway is more than 10o, chequered plate steps with nosing and toe guard shall be provided. The floor of conveyor gallery all along the gallery length, shall be provided with minimum 12 gauge thick seal plates and other drainage arrangements as specified elsewhere

Conveyor gallery shall have permanently colour coated steel sheet covers on roof and both sides. However in roof, a panel of minimum 1.5 m x 1.5 m area at about 6.0 m center shall be provided with translucent sheets of polycarbonate material for natural lighting. A

continuous slit opening of 500 mm shall be provided on both sides just below the roof sheeting. Adequate provision of windows shall be kept on both sides of conveyor gallery as mentioned elsewhere in the technical specification. Windows shall be provided with wire mesh as specified elsewhere in this specification.

Cross - over with chequered plate platform and ladder for crossing over the conveyors shall be provided at approximately every 100 M intervals of conveyor. Crossover shall preferably be located over four-legged rigid trestle location.

For railway tracks passing below overhead conveyor gallery and along conveyors, the railway clearances both underground as well as over ground shall have to be adhered to for design, execution and erection of foundations, trestles, galleries etc., so that movement of locomotives and wagons is not hampered in any way during execution and afterwards. However at the location where the overhead conveyor gallery crosses road / rail line, minimum clearance of 8.0m above the road crest / rail top shall be provided.

For calculation of material load on moving conveyor, a multiplication factor 1.6 shall be used to take care of inertia force, casual over burden and impact factor etc.

Thus material load per unit length of each moving conveyor shall be

$$1.6 \times \frac{\text{Rated Capacity of Conveyor system}}{\text{Conveyor Belt Speed}} \times F$$

Where, F = 1700/1400 for lime & 1250/900 for gypsum

It should be noted that for structural design, unit weight of lime shall be assumed as 1700 Kgs. / Cu. M. instead of 1400 Kgs. / Cu. M., unit weight of gypsum shall be assumed as 1250 Kgs. / Cu. M. instead of 900 Kgs. / Cu. M. considered for system sizing purpose. Conveyor Gallery structure shall be designed considering both conveyors operating simultaneously.

Conveyor gallery and supporting trestles located between transfer houses / buildings shall be arranged in any one of the following ways.

a) All gallery supporting trestles shall be four legged type only. One end of each gallery span shall be hinged to the supporting trestle and the other end shall be slide type. Slide type support shall be with P. T. F. E. bearings to allow both rotation & longitudinal movements.

b) In between transfer houses / buildings, four legged trestles shall be placed at a distance not more than 90 metres. The arrangement shall be such so as to ensure that force in the longitudinal direction (i. e. along the conveyor length) of conveyor gallery of length not more than 90 m is transferred to any four legged trestle. In the space between each successive four legged trestles, two legged trestles shall be provided at regular intervals. The end supports resting on the four-legged trestle can have either ends hinged or one hinge and the other on slide type depending on the

arrangements. Slide type support shall be with P. T. F. E. bearings to allow both rotation & longitudinal movements.

End of conveyor gallery which will be supported over transfer house, shall be so detailed that only vertical reaction is transferred from conveyor gallery and no horizontal force in longitudinal direction is transferred from conveyor gallery to transfer house structure and vice - versa.

For trestles and trestle foundations for conveyor galleries located adjacent to existing structures, over ground and underground facilities, location and details of these trestles and foundations shall have to be decided such that there is no interference both underground as well as over ground with existing structures and facilities. Trestle columns / ground conveyor portal column base shall be kept 300 mm higher than the existing ground level.

5.42.03 Transfer Houses

The over ground portion of the transfer house shall be framed structure of structural steel work with permanently colour coated profiled steel sheet side cladding and R. C. C. floors comprising of RCC slab over profiled metal deck sheets (to be used as permanent shuttering) over structural beams. Shear anchor studs shall be provided through metal deck at regular interval on all top flange/flange plate of structural beams. However the lower portion of side cladding for a minimum height of 0.9 m above the finished floor level shall be one brick thick wall plastered on both side. In some areas like MCC floors etc., one brick thick wall cladding shall be provided. Brick wall cladding shall be supported on encased wall beams and suitably anchored to adjoining columns and beams. Contractor shall have option to use tubular steel sections for roof truss only. All structures using tubular steel sections shall be shop-fabricated, shop painted and ready for erection at site.

Adequate steel doors and windows for proper natural lighting and ventilation shall be provided. In addition to steel windows, panels of suitable size to suit the architectural treatment and made of translucent sheets of polycarbonate material shall also be provided on the side cladding for natural lighting.

Pre-fabricated Insulated metal sandwich panels for roofing shall be used. The details are given elsewhere in the specification. Adequate slope in roof shall be provided for quick drainage of rain water.

5.42.04 Crusher House

The crusher house shall be framed structure of structural steel work with permanently colour coated profiled steel sheet side cladding. However, panels of suitable size to suit the architectural treatment and made of translucent sheets of polycarbonate material shall also be provided on the side cladding for natural lighting. The lower portion of side cladding for a height of minimum 0.9m above the finished floor level shall be of one brick thick wall plastered on both faces. Floors shall be of R. C. C. slab over profiled metal deck sheets (to be used as permanent shuttering) over structural beams. Shear anchor studs shall be provided through metal deck at regular interval on all top flange/flange plate of structural

beams. Within this building cubicles are to be provided for resting room of operators and these shall be constructed with one brick thick brickwork having both sides plastered and roof slab. Adequate steel doors and windows for natural lighting and ventilation shall be provided. Contractor shall have option to use tubular steel sections for roof truss only. All structures using tubular steel sections shall be shop-fabricated, shop painted and ready for erection at site.

Pre-fabricated Insulated metal sandwich panels for roofing shall be used. The details are given elsewhere in the specification. Adequate slope in roof shall be provided for quick drainage of rain water.

Crushers shall be supported on R. C. C. deck, which in turn will rest on suitable vibration isolation system consisting of springs and dampers. This R. C. C. deck shall be isolated from the floor. However, the vibration isolation system consisting of springs and dampers may rest on main building framework. Detailed specification of vibration isolation system including the unbalanced force, frequency and amplitude criteria and other design requirements are mentioned elsewhere in this specification.

5.42.05 Control building, M. C. C. Buildings

These shall be steel or RCC framed building with R. C. C. roof and floor. For steel framed building roof /floor shall comprise of RCC slab over profiled metal deck sheets (to be used as permanent shuttering only) over structural beams. Cladding shall be of brickwork/concrete blockwork with plastering on both sides.

All air - conditioned areas, shall be provided with the suspended permanently colour coated G.I false ceiling system (details specified elsewhere) with under deck insulation.
Adequate aluminium doors and windows shall be provided for natural lighting, ventilation and view. All windows in air conditioned rooms shall have hermetically sealed double glazing.

5.42.06 Pent House

These shall be of R. C. C. framed structures with columns, beams, slabs and foundations etc. Cladding shall be of brickwork with plastering on both sides. Roof shall be provided with roof water proofing treatment as specified elsewhere. Adequate nos. of doors and windows shall be provided for natural lighting and ventilation.

5.42.07 GYPSUM STORAGE SHED

The Gypsum storage shed shall be RCC framed structure with structural steel work shed with permanently colour coated profiled steel sheet roof and side cladding, grade slab and RCC foundations etc. Roof shall be provided with troughed profile permanently colour coated sheet with slope of 1 in 5 for quick drainage of rain water.

5.42.08 Toilets

Toilet with potable water line facilities shall be provided in each of the following locations:

a. Crusher House (Ground & Drive Floor)

b. In all M. C. C. Rooms

c. Control Building

5.42.09 Staircases

All floors of transfer/crusher houses and other facility buildings shall be accessible through staircase. All staircases of Transfer points and crusher house shall be of steel. Cage ladders (min. 450mm wide) shall be provided for access to roof of penthouses, single storey mcc rooms & mumty. All Stairs shall be minimum 1200 mm wide, maximum rise should not be more than 180 mm and minimum tread width 250 mm. Numbers and arrangement (including enclosures etc.) of stair cases shall be such as to meet the fire safety requirement as per guide lines of statutory regulatory bodies. For steel staircases, Stringers shall be of rolled steel channel (minimum ISMC 250) and tread shall be of steel gratings.Out side stairs to transfer points/crusher house shall be open type. Minimum 50 x 50 x 6 mm size angles with lugs shall be provided as edge protection for treads of stairs in underground TP's

All gratings shall be electro forged types. Minimum thickness of the grating shall be 40 mm for indoor installation and 32 mm for outdoor installation. However, at entry or road crossing point's minimum thickness of grating shall be 40 mm The opening size shall not be more than 30mmx100mm. The minimum thickness of the main bearing bar shall be 6 mm or as per design requirement whichever is higher. All gratings shall be designed for minimum imposed load of 500Kgs. / Sq. M. If actual expected load is more than the specified load, then actual load is to be considered. All gratings shall be hot dip galvanized at the rate of 610 g. per sq.m. after surface preparation by means of blast cleaning/ acid pickling.

Minimum 1000 mm high hand railing shall be provided around all openings, projections / balconies, walkways, platforms, Stairs, etc. All handrails and ladder Pipes shall be 32 mm nominal bore MS Pipes (medium class) as per IS:1161. Handrails shall have top and middle rails at a height of 1000 mm and 500 mm and the vertical post spacing shall not exceed 1.50 M, with provision of kick Plates (100 mm high and 6 mm thick). All handrails and ladders shall be galvanised at the rate of 610 Gms / Sq. M as per IS:4736.

5.42.10 Trenches

All trenches for cables or any other underground facility as detailed out elsewhere shall be of R. C. C. Cable trenches shall be provided with pre - cast R. C. C. covers / chequered plate cover. Cable trenches as well as pre - cast covers shall be provided with edge protection angles and lifting hooks. All embedments / block outs as required and specified elsewhere in these specifications shall be provided. Proper drainage arrangement shall be provided. Trench pre - cast cover weight shall not be more than 65 Kgs. Trench covers near entry or at road crossings shall be designed for 10 T wheel load at centre. Pre - cast covers shall be designed for central point load of 75 Kgs. R. C. C. cable trenches shall be filled with sand after erection of cables, up to top level and covered with pre - cast R. C. C. covers. For cable trenches outside buildings, top level shall be 200 mm above G. L.

Minimum 50 x 50 x 6 mm size angles with lugs shall be provided as edge protection all around cut outs / openings in floor slabs, edges of drains supporting grating/precast RCC

covers, edges of R. C. C. trenches supporting pre - cast covers, supported edges of pre - cast cover, treads of RCC stairs.

5.42.11 **Cable gallery/trestles**

Cable galleries/trestles shall be made of structural steel. The contractor can use either rolled sections or tubular steel sections. The tubular steel section shall be of circular/rectangular/square shape. The circular steel tube shall conform to IS:1161 and rectangular/square steel sections shall confirm to IS:4923. The steel structures using tubular sections shall be designed and fabricated as per IS:806 – "Code of Practice for use of steel tubes in general building construction." and EN 1993-1-8:2005.

5.42.12 **Transformer Foundation**

Foundations of transformers shall be designed for seismic and wind loads in addition to other applicable loads. Block foundations shall be provided for the main transformer block.

The oil soak pit, if provided, shall be filled with gravel of size 40mm. The volume of the soak pit shall be sufficient to store complete oil of the transformer/reactor along with 10 minutes of fire water considering only 40% of the volume as available voids between gravel filling. However, in case a separate oil collection tank is provided for the transformer/reactor, oil soak pit of volume equivalent to one-third (1/3) the oil volume of transformer/reactor shall be provided around transformer/reactor. The oil collection tank, in such cases, shall be designed for an effective capacity of complete oil of the transformer along with 10 minutes of fire water. The oil soak pit shall also be provided with a sump at the corner to allow drainage of water/oil from the soak pit.

Arrangement for moving the transformer into place using rail cum road, jacking pads and pulling blocks including inserts, as required, shall be provided along with the transformer/reactor foundations.
RCC Firewall shall also be provided between the transformers wherever required.
300 mm thick PCC M20 encasement all around the Pylon supports inside soak pit for fire fighting system shall be provided up to top of gravel filling. Coarse aggregate filling inside the transformer oil soak pit shall be carried out only after construction/erection of Pylon supports and PCC encasement.

5.42.13 **Booster Fan Foundation**

Booster Fan foundations shall be RCC block foundation directly resting on virgin soil/ pile below Ground level. The vertical faces of this block foundation shall be isolated from adjacent footings by providing minimum 100mm thick polystyrene board of type-1 conforming to IS: 4671 with density 20 Kg/cum sandwiched between the vertical face of block foundation and 230 thick brick wall all round.

5.42.14 **PTFE (Poly Tetra Fluoroethylene) Bearing**

The bearing shall be of reputed make and manufacturer as approved by the Engineer, for required vertical load and end displacement/rotation. PTFE bearing shall be sliding against highly polished stainless steel and the coefficient of friction between them shall be less than 0.06 at 55 kg/sq.cm. In order to prevent cold flow in PTFE surface it shall be rigidly bonded by a special high temperature resistance adhesive to the stainless steel substrata. The stainless steel surface that slides against the PTFE is mirror polished. The stainless steel shall be bonded to the top plate by special high strength adhesive. The thickness of stainless steel plate shall be between 1.0 mm to 1.5 mm.

5.42.15 CHEMICAL INJECTION GROUTING

Minimum, 12 mm dia (NB) threaded nozzle of suitable length, shall be provided over the surface and along the construction joint line in a grid pattern at a spacing not exceeding 1.5 m c / c before concreting operation. Adequate precaution shall be taken to keep the nozzles plugged at both ends to prevent them from getting closed by concrete.

For fixing of any nozzle in set concrete suitable size hole shall be drilled, preferably by using repercussive hammer drill electrically operated, in grid pattern and grouting nozzle shall be fixed in these holes.

After the nozzles are fully set, neat cement slurry admixed with water soluble non - shrink polymer / monomer based chemical shall be injected through the net - work of nozzles with low pressure grout pumps at a pressure of about 2.0 Kgs. / cm2. Cement slurry shall be prepared by mixing cement with non-shrink polymer/monomer @ 500 gm/50 kg bag of cement and water, ensuring that Water: Cement ratio does not exceed 2 (by weight). Wetter the structure, lesser should be the water cement ratio. The property of the polymer/monomer should be such that when it is mixed with water @0.5% by weight of water, the viscosity of the resultant solution (water and polymer/monomer) should not be more than 1.2 centipoises. Plasticizing agent shall be added wherever required. The grouting shall be started at very low pressure and increased gradually to a required pressure. The grouting shall continue, till the hole refuses to take any further grout, even at an increased pressure. Applied pressure shall not be more than the designed strength of the concrete. After completion of grouting operation, the nozzles shall be sealed properly to the satisfaction of the Engineer.

5.42.16 POLYMER MODIFIED CEMENTITIOUS COATING

(i) Materials

Modified liquid polymer blend shall be a dispersion containing 100 % acrylic based polymer solids. Polymer shall be mixed in the ratio of 1 cement: 0.5 polymer (for minimum solid content of polymer 30%).

Portland cement based dry powder.

Clean, fine specially prepared quartz sand approximately 0.6 mm size.

(ii) Mixing

The liquid polymer shall be stirred well and cement based powder shall then be added slowly to make a Slurry Mix. For preparation of Brush Topping Mix, quartz sand shall be added slowly and mixed well till a homogeneous mixture is obtained. The mix shall be used within half an hour of the preparation. Addition of quartz sand may not be necessary, in case dry power contains the same.

(iii) Properties of Coating

It must adhere to wet surface.

It should develop adequate bond strength, with the concrete surface, not less than 2 N / Sq. mm.

Co - efficient of permeability shall be about 5x10-10 Cm / Sec.

Water absorption after continuous soaking shall not be more than 1 %.

The materials shall be permeable under water vapour.

The material shall be resistant to acids and alkalies present in the soil and underground water with normal pH value between 4 and 14.

The co - efficient of thermal expansion of the material shall be close to that of concrete.

(iv) Application

The concrete surface shall be cleaned and made free from grease, oils or loosely adhered particles. The surface shall be damp without any free water. For exterior underground part, application (b) pertaining to Brush topping Mix shall be followed.

(a) For Slurry Mix

A minimum of 2 coats shall be applied on the surface. The first coat being applied, when the surface is still damp and left to harden for 4 to 6 hours. After 4 to 6 hours of the application of second coat, it shall be finished by rubbing down with a soft dry sponge. The coverage shall not be less than 1 : 1 Kgs. / m2 in the 2 coats. A lap of 75 mm shall be provided at the joints.

The coating shall be air dried for 4 to 6 hours and, thereafter, cured for 7 days after the application of last coat.

(b) For Brush Topping Mix

This shall be applied in two coats. A primary coat of slurry mix can also be first applied on the surface as first coat. After the coating has dried up, a coat of Brush Topping Mix shall be applied over it with a push broom or any other similar brush. It shall be left in broom finished condition. The nominal thickness shall be 1.5 mm and minimum thickness shall be 1.0 mm. A lap of 75 mm shall be provided at the joints. It shall be ensured that no pinhole exists and rebrushing shall be done to cover the pinholes, if any.

The Coating shall be air dried for 4 to 6 hours and thereafter cured for 7 days after the application of last coat.

Rate of application of coating shall be established to achieve the required thickness.

5.42.17 SHOTCRETING

(i) **General Requirements**

Generally, shotcreting shall be done in accordance with IS : 9012.

Reinforcement for shotcreting shall be as detailed below, unless specified otherwise.

Reinforcement in one direction consisting of 6 mm M. S. bars at 750 mm c / c shall be connected to the lugs for fastening of the wire fabric. This shall be used in case of 50 mm or above thick shotcreting.

Wire fabric conforming to IS : 1566 shall be used as reinforcement and shall consist of wire, 3 mm diameter, spaced 50 mm both ways and shall be electrically cross welded. Wire fabric shall be securely tied to 6 mm bars for 50 mm thickness. Adjacent sheet of wire fabric shall be lapped at least 100 mm and tied.

Clear cover to reinforcement mesh shall not be less than 15 mm.

Minimum thickness of shotcreting shall be 50 mm. for abrasion resistant work and 25 mm for ordinary surface protection work.

(ii) Material

Generally, the materials shall be in accordance with aggregates specification given hereunder.

Fine aggregate shall consist of natural sand or crushed stone from a known source and shall be strong, hard, coarse, sharp, chemically inert, clean and free from any coating. It shall be

free from clay, coal or coal residue, organic or any other impurities that may impair the strength or durability of the concrete and shall conform to IS : 383.

Fine aggregate (Sand) shall be well graded and particles shall range in size within the following limits. The Engineer, may approved the use of any other grading as per requirement or as per IS : 9012.

The fineness modulus shall be preferably between 2.5 and 3.3. Any other value can be used, with prior approval of the Engineer.

(iii) Application

After the placement of reinforcement and / or welded mesh and not more than six hours prior to the application of shotcrete, the surface shall be thoroughly cleaned of all loose materials and dirt. The Contractor shall properly prepare the surfaces, reinforcement and / or welded mesh to receive the shotcrete. Cleaned surfaces shall be wetted not more than hour prior to shotcreting.

The mix as placed on surface shall be one part cement to three parts approved sand by mass. Cement and sand shall be dry mixed; not water shall be added after mixing and before using in the gun. The quantity of water when added shall be only that which is sufficient to hydrate the cement. For average atmospheric conditions, the water cement ratio for shotcrete in place shall be between 0.35 and 0.5 by mass. Suitable admixture shall be used wherever required.

A uniform pressure of not less than 3 Kg/cm2 at the nozzle shall be maintained. Necessary adjustments shall be made to ensure this pressure, taking into account the length of hose and height of the place to be shotcreted, above location of the machine.

The application shall proceed in an upward direction. Beams, stiffeners and intermediate walls, if any, shall be wrapped with wire fabric and completely covered with shotcreting. All rebound shall be removed from the area of application as the work progresses and such rebound material shall not be reused.

As soon as the freshly shotcreted surface shows the first dry patches, a fine spray of water shall be applied to keep too moist. After the surface has hardened, it shall be kept continuously moist for minimum seven days. If there is extreme heat, especially when accompanied by hot winds, the shotcreted surface, immediately upon completion, shall be covered with burlap or similar covering, which must be kept continuously moist for 14 days after shotcreting. The temperature of the lining shall not be permitted to exceed 380C during placing of concrete.

5.42.18	**Design criteria** The design of all R. C. C. structures shall be carried out as per 'code of practice for plain and reinforced concrete for general building construction', IS : 456 (latest).
5.42.18.1	Minimum size of the angle section to be used as structural members shall be 50 X 50 X 6. Minimum weld size shall be 6 mm. Connections shall be designed for 70 % of shear capacity of the member or the actual shear force, whichever is higher. The steel structures using tubular sections shall be designed and fabricated as per IS:806 – "Code of Practice for use of steel tubes in general building construction." and EN 1993-1-8:2005
5.42.18.2	The building shall conform to local bye - laws, rules and regulations for industrial buildings and also B. I. S. publications, SP 32 and 41.
5.42.18.3	Slotted holes shall not be assumed to act as expansion joint for relieving of stresses and suitable bearings shall be provided at the supports.
5.42.18.4	All gallery supporting trestles shall be so proportioned that the transverse deflection of gallery due to wind / seismic load should not exceed trestle height / 1000 as stipulated in IS: 11592. This deflection condition shall be strictly followed. Peak wind speed method shall be considered for checking the transverse deflection.
5.42.18.5	The crusher and transfer house structures shall be so designed that, should be equal to the respective transverse deflection of conveyor supporting trestles transverse deflection at places where conveyor galleries meet.
5.42.18.6	Stresses for all structures shall be checked for the higher of the forces obtained from gust factor method and the peak wind speed method.
5.42.18.7	Horizontal bracing system shall be provided at floor levels around the openings.
5.42.18.8	Shear force in steel columns shall be transferred to the pedestals / foundations exclusively either through foundation bolts or the shear key arrangement.
5.42.18.9	For design of liquid retaining structures, IS : 3370 (Part - I to IV) (latest) shall be followed. Face of the structure in contact with liquid shall be designed as un - cracked section. For design of R. C. C. pipes for culverts, latest editions of IS : 458, IS : 783 should be followed.
5.42.18.10	For design of all underground structures / foundations, ground water table shall be assumed at the formation level (i. e. the adjoining ground level). For all underground structures like

tunnel, underground transfer point and relcaim hopper etc. crack width shall be limited to 0.2mm.

5.42.18.11 Design of Hopper walls shall be done for both Static & Dynamic flow condition using Walker's theory.

5.42.18.12 Design of masonry walls shall be made as per IS : 1905.

5.42.18.13 Civil task drawing indicating various equipment loading and supporting arrangement and floor loads to be submitted along with the design calculation.

5.42.18.14 Minimum reinforcement shall be provided at the top face of the footing, even if, no reinforcements are required as per design.

5.42.18.15 Foundations for all tanks shall be designed for as per IS: 803.

5.42.18.16 Footings shall be so proportioned to as to minimise the differential settlement.

5.42.18.17 Deflection criteria shall be followed as given elsewhere in the specification.

5.42.18.18

a) Dispersion of load in any direction through soil shall be as per IS: 8009 (relevant part).

b) Dispersion of load through concrete shall be considered at an angle of 45 degrees with horizontal from the edge of contact area.

5.42.18.19

a) The design and construction of RCC structures shall be carried out as per IS: 456. Working stress method shall be adopted for the design wherever specifically mentioned in this specification.

b) For design and construction of steel-concrete composite members, IS: 11384 shall be followed.

c) For reinforcement detailing, IS: 5525 and SP: 34 shall be followed.

d) Two layers of reinforcement (on both inner and outer faces) shall be provided for RCC wall sections having thickness 150 mm or more.

5.42.18.20

a) All RCC liquid retaining/conveying shall be designed by working stress method as outlined in clause no. 4.5 of IS 3370 (Part-2) 2009 unless specified other wise.

b) Water proofing treatment shall be provided for liquid retaining/ carrying structures and basement type structures (requiring dry working condition). Dense and durable concrete with water cement ratio not more than 0.45 shall be used. Plasticiser /super-plasticiser cum water proofing compound shall be added to the concrete. All the construction/expansion joints shall be provided with PVC water bar and/or chemical injection grouting as per IS:6494. As applicable internal/external surface of

such structures shall be provided with acrylic based polymer modified cementitious composite coating system for critical structures. For liquid carrying/retaining structures, minimum two coats of such coating shall be applied. For external application wherever the surface is in contact with the earth, fine silica/quartz sand of 0.6 mm nominal size shall be added in the coating mix for better abrasion resistance and total nominal thickness of such coating shall be minimum 1.5 mm. For non critical structures minimum two coats of bitumen grade 85/25 as per IS:702, mixed with 1% of anti-stripping compound meeting the requirement of IS:6241, shall be applied. The total application of bitumen shall not be less than 1.7 kg/sq.m.

Bidder shall submit a comprehensive scheme for water proofing treatment based on above or any other alternative scheme, internationally accepted for Employer's approval prior to commencement of work.

c) All liquid retaining/carrying structures shall be tested for water tightness as per the provisions of IS: 3370 and IS: 6494 and in case of leakage, the same shall be rectified by chemical injection grouting through nozzles.

5.42.18.21 For design of all underground structures, foundations, etc. ground water table shall be assumed at the finished ground level unless specified otherwise.

5.42.18.22 Earth pressure for all underground structures shall be calculated using coefficient of earth pressure at rest or co-efficient of active earth pressure, whichever is applicable, depending upon the structural configuration. However, for the design of substructure of pump houses, earth pressure at rest shall be considered. Co-efficient of passive earth pressure shall be used only in design of shear keys for stability against sliding.

5.42.18.23 a) Following loading conditions shall be considered in addition to the loading from super structure for the design of substructure of pump house, channels, sumps, tanks, trenches and other underground structures containing liquid

i) Water pressure from inside and no outside pressure, like earth pressure, ground water and surcharge pressure (applicable only to structures, which are liable to be filled up with water or any other liquid.)

ii) Earth pressure, surcharge pressure and ground water pressure from outside and no water pressure from inside.

iii) Design shall also be checked against buoyancy due to the ground water during construction as well as after construction stages. Minimum factor of safety of 1.2 against buoyancy shall be ensured considering empty condition inside and ignoring the superimposed loadings. Provision of pressure relief valves/flap valves, etc., shall not be permitted to counter the buoyancy unless specified otherwise.

iv) Base slab and piers of the pump houses shall also be designed for the condition of different combination of pump sumps being empty during maintenance stages with maximum ground water level.

b) Intermediate dividing pier of pump sumps and partition wall (if applicable) in channel shall be designed considering water on one side only and other side being empty for maintenance.

c) All pump houses and other substructures (wherever applicable) shall be checked for stability against sliding and overturning during construction as well as operating conditions for various combinations of loads.

5.42.18.24 **Block Foundations:**

a) Block foundation resting on soil shall be analyzed using elastic half space theory. In case the foundation is supported over piles, Novak's approximation shall be used for determining the spring constant and damping ratio of pile groups. The mass of the RCC block shall be at least three times the mass of machine. Free vibration analysis of the foundation shall be carried out to evaluate the natural frequencies. The fundamental natural frequency shall be kept at least 20% away from the operating frequency (speed). Forced vibration analysis shall be carried out if the dynamic forces are made available by the machine supplier in which case the amplitude limits stipulated by the machine supplier and ISO 10816, whichever is lower, shall be satisfied.

Reinforcement design shall be done by working stress method as per IS:456-2000 and IS:2974 (Part-IV).

b) For the foundations supporting minor rotating equipment weighing less than one ton or if the mass of the rotating parts is less than one hundredth of the mass of the foundation, no dynamic analysis is necessary. However, if such minor equipment is to be supported on building structure, floors, etc., suitable vibration isolation shall be provided by means of springs, neoprene pads, etc., and such vibration isolation system shall be designed suitably

5.42.19 **VIBRATION ISOLATION SYSTEM**

These specifications are meant for the design, supply and erection of vibration isolation system for supporting crushers.

5.42.19.1 Supporting Arrangement

For Crushers:

The crushers shall be supported on vibration isolation system consisting of steel helical springs and viscous dampers. The supporting arrangement for each crusher shall consist of an R. C. C. deck supported on steel helical spring units and viscous damper units which in turn shall be supported on girders. The girders shall be an integral part of the crusher house building.

The part of the structure consisting of the R. C. C. deck, springs and viscous dampers shall hitherto be referred to as "spring supported foundation". The part of the structure, which is below the spring shall hitherto be called "supporting structure".

The Contractor should do the Engineering / design, supply and erection of vibration isolation system consisting of steel helical spring units and viscous dampers supporting the top deck

which in turn would support the crushers.The vibrations isolation system supplied shall be of a proven make. The Contractor or his sub - contractor who designs and supplies the system should have designed, supplied and installed such systems for not less than five machines of speeds and unbalance forces comparable to the machine proposed by the vendor. The vibration isolation systems installed by the contractor or his sub - contractor in such machines should have been working satisfactorily for at least five years.

5.42.19.2 Scope of Work

Scope of work shall include the following :

(a.) Engineering

(1.) Design of the vibration isolation system using steel helical springs and viscous dampers to support an R. C. C. top deck supporting the equipment. This includes the static and dynamic analysis of the vibration isolation system with the R. C. C. top deck and the equipment.

(2.) Structural design of the R. C. C. top deck including preparation of General Arrangement drawings, detailed reinforcement drawings, bar - bending schedules etc.

(3.) Calculation of loads on the structure supporting the springs and viscous dampers, their points of application and the stiffness requirements of the supporting structure.

(4.) Drawings showing embedments and their locations and details on the R. C. C. top deck.

(5.) Drawings showing blockouts, recesses etc. on the top deck.

(6.) Design of the supporting structure, including preparation of detailed drawings and bill of materials.

(b.) Supply including packing and transportation to site

(1.) Steel helical spring units and viscous dampers, including associated auxiliaries for installation of the spring units and dampers like steel shims, adhesive pads etc.

(2.) Frame (s) for pre-stressing of spring elements.

(3.) Suitable hydraulic jacks system including electric pumps, high pressure tubes etc. required for the installation, alignment etc. of the spring units, two extra hydraulic jacks, one hand operated pump and spares for the hydraulic jack system as required.

(c.) Erection and Commissioning

(1.) Complete erection and commissioning of the vibration isolation system including :

(2.) Pre-stressing of spring elements, placing of spring elements in position, checking clearances on the shuttering of the R. C. C. top deck, construction of the supporting structure and the R. C. C. top deck, releasing to pre-stress in spring elements and making final adjustments and alignments after machine installation etc.

(3.) The scope of work shall be deemed to include all activities which may not have been explicitly mentioned but are reasonably implied for the successful completion of the work for which these specifications are intended.

(4.) This part of the specifications is for vibration isolation system. For the construction of the supporting structure for the crusher and the top deck, the relevant parts of the specification should be referred to.

(d.) Documentation

(1.) Submission of detailed design calculation, analysis (static and dynamic) and drawings for Employer's acceptance and approval.

(2.) Furnishing methodology of providing shuttering and its removal as well as concreting of deck slab, installation of springs and dampers and the sequence of operation.

(3.) Furnishing installation and maintenance manual indicating equipment, procedure etc., necessary for installation, maintenance of vibration isolation system.

(4.) Furnishing a check list for confirming the readiness of the civil fronts for the installation of vibration isolation system and equipment required at each stage installation.

(5.) Bill of materials of various elements such as springs, visco-dampers, with their rating, stiffness etc., included in supply.

(6.) Detailed specifications of the vibration isolation system and various items included in the supply and the standard (local or international) to which they conform.

(7.) Proposed erection strategy of the entire system.

5.42.19.3 Design Requirements for Crusher RCC Deck

(i) Dynamic Analysis

Detailed dynamic analysis shall be done for the top deck together with springs and dampers and the natural frequencies and amplitudes of vibration shall be determined. A mathematical model of the top deck shall be formulated with three - dimensional beam / plate finite elements for the purpose of analysis with the spring idealised with vertical and horizontal stiffnesses. The mass of the machine together with that of the top deck shall be considered for the analysis.

Natural frequencies up to at least 10 % above the operating speed shall be determined and these frequencies shall be checked against the design criteria.

Forced response dynamic analysis shall be carried out for the operating condition unbalance forces using a sinusoidal forcing function. Unbalance forces as given by this specifications shall be used for his purpose. The amplitudes shall be checked against the design criteria. The dynamic forces from this analysis shall be used for structural design with a suitable fatigue factor.

(ii) Isolation Efficiency

The vibration isolation system shall be designed for about 90 % isolation efficiency.

(iii) De-coupling

A ratio of the least 10 (ten) shall be ensured between the stiffness of the supporting structure and the stiffness of the spring system in the vertical direction to achieve de-coupling between the two (the stiffness of the spring system being lower). This ensures that dynamic analysis of the supporting structure need not be carried out.

(iv) Frequency Criteria

The frequency criterion has already been laid down implicitly by the isolation efficiency criteria and de-coupling required.

The first bending mode frequency of the top deck shall be at least 20 % above the operating speed.

(v) Unbalance Forces for Crushers

Unbalance forces arising out of all the following cases shall be considered for checking the design and amplitudes.

(a.) Balance quality grade Q 40 as per ISO 1940.

(b.) One hammer broken condition. The missing hammer shall be assumed to be closest to the crusher non - drive end of the crusher.

(c.) Three hammers broken condition. All the three hammers broken shall be assumed to be from the same suspension bar and located at the non - drive end of the crusher.

(vi) Amplitude Criteria for Crushers

The calculated amplitudes (mean to peak values) shall not exceed following limits under the specified conditions.

1) Operating speed of 750 RPM

(a.) 150 microns for an unbalance force arising out of balance quality grade Q 40 as per ISO 1940.

(b.) 300 microns in case of a one hammer broken condition.

(c.) Amplitudes need not be checked for a three hammer broken condition.

2) Operating speed of 450 RPM

(a.) 200 microns for an imbalance force arising out of balance quality grade Q-40 as per ISO 1940.

(b.) 400 microns in case of a one hammers broken condition.

(c.) Amplitude need not be checked for a three hammer broken condition.

For intermediate operating speed between 450 to 750 RPM the amplitude limits can be linearly interpolated.

The amplitude limits mentioned above are in both vertical and horizontal directions. The amplitudes shall be calculated at critical points on the top surface of the R. C. C. deck. The amplitudes shall be checked for the most unfavorable superposition of modes in any direction. However, phase difference between the maximum amplitude occurring in different directions due to the rotating vetor may be considered while superimposing the modes.

(vii) Transient Resonance

Transient resonance, which may occur during the start - up or coasting down condition of the crusher, shall be checked, and the amplitudes in such a condition should not exceed one - and - half times those at operating speed for each design condition.

(viii) Strength Criteria

The following criteria shall apply for the design of top deck:

(a.) Dead loads, live loads, Seismic loads and dynamic loads shall be considered for the design. The most unfavorable combination shall considered for design.

(b.) Seismic loads shall be assumed to act together with dynamic loads for a one millimeter eccentricity in the rotor. However, seismic loads and dynamic loads arising out of hammer breakage need not be considered together

(c.) Fatigue shall be considered while designing for dynamic forces. A fatigue factor of 2.0 shall be used on all dynamic forces to arrive at the equivalent static force for the purpose of design.

(d.) Working stress method shall be used for the design of R. C. C. deck. In survival condition, 10 % overstressing may be permitted.

(e.) The R. C. C. top deck shall be at least of M35 grade of concrete as per IS: 456.

(f.) Fatigue need not be considered for the three hammer broken condition.

(g.) For calculating unbalance forces, the heaviest hammer (plain or toothed) shall be considered.

(ix) Approval of Designs and Drawings

All design calculation, drawings and documents shall be in English. All design calculations and drawings shall be submitted to Employer for approval. However, approval of such designs and drawings shall not relieve the contractor of his responsibility regarding the adequacy of the foundation to carry the design forces.

(x) Standards

Latest revisions of the following Codes shall be used for the design of the crusher foundations.

(a.) IS : 456 Code of Practice for Plain and Reinforced concrete.

(b.) IS : 2974 (Part IV) Code of Practice for Design and Construction of Machine Foundations (Part IV) for rotary type machine of low frequency.

(c.) IS : 1893 (Criteria for Earthquake Resistant Design of Structures).

(d.) DIN 4024 Machine Foundations :

Flexible supporting structures for machines with rotating masses.

(e.) DIN 2089

Helical Compression Springs out of round wire and rod; calculation and Design.

(f.) DIN 2096

Helical Compression Springs out of round wire and rod; quality requirements for hot formed compression springs.

(g.) VDI 2056 - Criteria for assessing mechanical vibrations of machines.

(h.) VDI 2060 - Criteria for assessing the state of balance of rotating rigid bodies. not be permitted to exceed 38°C during placing and curing

5.42.20 For other provisions, relevant clauses specified in Sub-section-D-01 Civil Works, Section-VI, Part-B (Book 4 of 6) of technical specification shall be followed.

Annexure-V

TABLE-B
FINISHING SCHEDULE

12.	**FGD SYSTEM BUILDINGS**			
		Flooring & Skirting	**Wall**	**Ceiling**
	a) Non Air-conditioned space.	Cement concrete with Metallic hardener topping	Acrylic distemper over wall putty	Acrylic distemper
	b) R.C.C Staircase	18 mm thick granite flooring	1200 high Glass mosaic tiles and Acrylic Emulsion paint over wall putty above	Acrylic distemper
	c) Toilet area	Heavy Duty Dust pressed ceramic tiles.	Designer ceramic wall tiles dado up to false ceiling level.	Calcium silicate false ceiling
	d) Battery room	Acid, Alkali resistant tile	Acid/Alkali resistant tile and chemical resistant paint above dado.	Chemical resistant paint.
	e) Entrance/ Reception	18 mm thick Granite Stone	Acrylic emulsion paint and Glass Mosaic tiles cladding	Acrylic distemper
	f) Passages	18 mm thick Granite Stone	Acrylic emulsion paint	Acrylic distemper
	g) Air-Conditioned Space	Vitrified Ceramic Tiles	Acrylic emulsion paint	GI clip in metal false ceiling

GEOTECHNICAL INVESTIGATION REPORT

PROJECT: 3X800MW PATRATU STPP

BHEL DOCUMENT NO: PE-DC-434-602-C001, Rev-2

NTPC DOCUMENT NO: 9585-001-301-PVC-W-130

MAIN PLANT AREA

VOLUME-I

Customer

NTPC Limited

Submitted by

PROJECT ENGINEERING MANAGEMENT

POWER PROJECT ENGINEERING INSTITUTE

HRD & ESI COMPLEX

PLOT NO.: 25, SECTOR-16A

NOIDA (U.P.) - 201 301

REPORT ON
GEOTECHNICAL INVESTIGATION WORK
AT 3X800MW PATRATU STPP
JHARKHAND

MAIN PLANT AREA

(Volume I: Methodology, Analysis & Recommendations)

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REPORT ON
GEOTECHNICAL INVESTIGATION WORK AT
3 x 800 MW PVUNL PATRATU STPP
AT RAMGARH, JHARKHAND

1. INTRODUCTION

Patratu Vidyut Utpadan Nigam Limited has proposed the construction of 3 x 800 MW Patratu Super Thermal Power Project at Ramgarh, Jharkhand and the job was awarded to **M/s. Bharat Heavy Electricals Limited**. For designing of Foundation Structures coming under this project, it was necessary to conduct a Detailed Geotechnical Investigation Work and **M/s Bharat Heavy Electricals Limited**, in turn awarded the job to **M/s. C. E. Testing Company Pvt. Ltd., Kolkata.**

This is a part of the whole project and deals with soil investigation around Main Plant Area**.** The scope of the work comprises of sinking 194 nos. Boreholes, 33 nos. Trial Pits (TP), 17 nos. Plate Load Tests (PLT), 13 nos. Cyclic Plate Load Tests (CPLT), 32 nos. Dynamic Cone Penetration Tests (DCPT), 22 nos. Field Permeability Tests (FPT), 58 nos. Electrical Resistivity Tests (ERT), 09 nos. Pressure Meter Tests (PMT) and 12 nos. Crosshole Shear Tests (CST).

The boreholes of 150 mm diameter were advanced by Shell and Auger method in soil. In rock, rotary core drilling of “NX” size was adopted. The scope also included conducting Standard Penetration Tests, collecting disturbed samples at regular intervals for identification and logging purposes, collecting undisturbed tube samples at suitable intervals or at change of strata whichever is earlier and testing these in the laboratory.

Based on the above, this report presents the Bore Logs, Soil Profile, laboratory and field Test Results. On the basis of field tests and laboratory test results and their analysis thereof, the most suitable type of foundation is suggested.

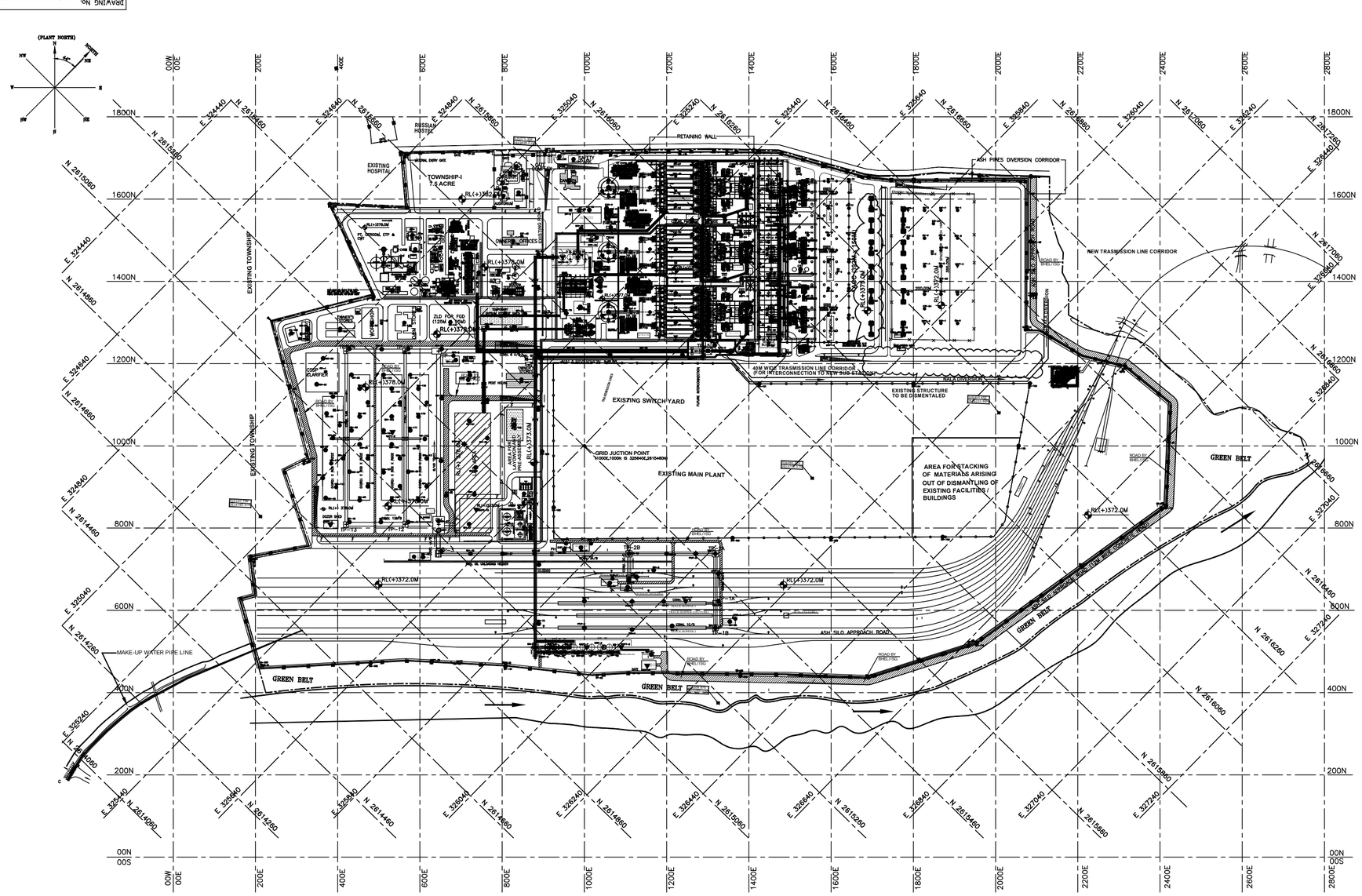
The subsoil is characterised by silty clay / silty sand layer with varying consistency. After the soil layer, weathered rock layer is struck and that continues upto the terminating depth of all the boreholes. However, at few locations filed up soil / fly ash has been observed at top.

Considering the nature of the subsoil as revealed from field tests, shallow foundation is

recommended. However, this is discussed in details later.

The Geotechnical Investigation Report has been divided into four parts (volumes) as detailed below.

- **Volume – 1 / Main Plant Area: Methodology, Analysis & Recommendations.**
- **Volume – 2 / Main Plant Area: Bore logs, Field & Laboratory Test Results.**
- **Volume – 3 / CHP & AHP Area: Methodology, Analysis & Recommendations.**
- **Volume – 4 / CHP & AHP Area: Bore logs, Field & Laboratory Test Results.**



N O T E S:–

1. ALL DIMENSIONS ARE IN METERS UNLESS NOTED OTHERWISE.
2. BORE HOLE SHALL BE DRILLED UPTO THE DEPTH INDICATED AGAINST EACH BORE HOLE OR UPTO 5M IN ROCK WITH CONTINUOUS RQD OF 50% WHICH-EVER IS EARLIER.
3. BACKFILLING OF BORE HOLES AND PITS SHALL BE AS PER SPECIFICATION AND AS DIRECTED BY THE ENGINEER-IN-CHARGE.
4. STARTING DEPTH OF STANDARD PENETRATION TEST (SPT) SHALL BE 1M BELOW GROUND LEVEL AND THE TEST SHALL BE CONDUCTED AT EVERY 1M INTERVAL ALTERNATE TO COLLECTION OF UNDISTURBED SAMPLE (UDS) UPTO 5M DEPTH BELOW GROUND LEVEL AND AT EVERY 1.5M INTERVAL ALTERNATE TO COLLECTION OF UDS BEYOND 5M DEPTH, AT CHANGE OF STRATA & AT DEPTHS WHEREVER UDS COULD NOT BE COLLECTED.
5. STARTING DEPTH OF COLLECTION OF UDS SHALL BE 2M BELOW GROUND LEVEL AND UDS SHALL BE COLLECTED AT 1M INTERVAL ALTERNATE TO CONDUCTING SPT UPTO 5M DEPTH BELOW GROUND LEVEL & AT EVERY 1.5M INTERVAL ALTERNATE TO CONDUCTING SPT BEYOND 5M DEPTH.
6. CROSS HOLE SHEAR WAVE TEST SHALL BE CARRIED OUT AT 2M, 4M, 6M, 8M, 10M, 12M, 15M, 18M, 20M, 25M & 30M DEPTH BELOW GROUND LEVEL.
7. PUMP IN TYPE FIELD PERMEABILITY TEST SHALL BE CARRIED OUT AT DEPTH 1M, 3M, 5M, 8M AND 10M BELOW EXISTING GROUND LEVEL IN BH-1, BH-7, BH-11, BH-17, BH-24, BH-37, BH-48, BH-67, BH-72, BH-77, BH-84, BH-89, BH-91, BH-101, BH-104, BH-112, BH-115, BH-123, BH-128, BH-140, BH-152, BH-161, IBH-1, IBH-2, IBH-3, IBH-35, IBH-41, IBH-54, IBH-85, IBH-86 AND IN IBH-5 & IBH-7 THE TEST SHALL BE CARRIED OUT AT DEPTH 1M, 4M, 7M, 10M, 13M, 16M & 20M BELOW EXISTING GROUND LEVEL.
8. ELECTRICAL RESISTIVITY TEST SHALL BE CARRIED OUT BY WENNER'S METHOD.
9. PRESSURE METER TEST SHALL BE CARRIED OUT AT 2M, 4M, 6M, 8M, 10M, 12M, 15M, 18M, 20M, 25M & 30M DEPTH BELOW GROUND LEVEL.
10. GROUND WATER SAMPLE SHALL BE COLLECTED FROM BH-2, BH-13, BH-23, BH-26, BH-36, BH-45, BH-48, BH-58, BH-68, BH-81, BH-87, BH-92, BH-94, BH-102, BH-105, BH-113, BH-124, BH-127, BH-143, BH-151, IBH-22, IBH-30, IBH-32, IBH-39, IBH-45 AND IBH-80.
11. PLATE LOAD TEST (PLT) SHALL BE CONDUCTED IN TP-1 TO TP-17 AND ITP-1 TO ITP-7 AT 3M DEPTH BELOW GROUND LEVEL.
12. CYCLIC PLATE LOAD TEST (CPLT) SHALL BE CONDUCTED IN TP-18 TO TP-30. AT 3M DEPTH BELOW GROUND LEVEL.
13. IN TP-1 TO TP-30 AND ITP-1 TO ITP-7, EXCAVATION BELOW 3M DEPTH SHALL BE DONE AFTER CONDUCTING PLT/CPLT AS PER NOTE 11 & 12.
14. GEOTECHNICAL INVESTIGATION SHALL BE CARRIED OUT AS PER SPECIFICATION.
15. DO NOT SCALE THIS DRAWING.

REF DRG :

1. PE-DG-434-100-M001, REV-0P "PLOT PLAN".

GEOTECHNICAL INVESTIGATION LEGEND:

1. BOREHOLE (BH/IBH) . . . . . ●
2. TRIAL PIT (TP/ITP) . . . . . ▨
3. DYNAMIC CONE PENETRATION TEST (DCPT/IDCPT) . . . . . ▼
4. PRESSURE METER TEST (PMT/IPMT). . . . . ⊕
5. CROSSHOLE SHEAR TEST (CST/ICST). . . . . ⊙
6. ELECTRICAL RESISTIVITY TEST (ERT/IERT) . . . . . ◎

BHEL–PROJECT ENGINEERING MANAGEMENT(CIVIL)
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☐ PLANNING/INFORMATION
☑ CONSTRUCTION
STAMP ALL PREVIOUS REVISION AS SUPERSEDED
ISSUED BY
NAME: PANKAJ KUMAR
SIGNATURE: –SD–
DATE: 29/01/2018

TRIAL PIT (ITP)			DEPTH BELOW EGL(M)
MARKING	CO-ORDINATES		
ITP–1	392 E	1087 N	3.0
ITP–2	595 E	999 N	3.0
ITP–3	309 E	1260 N	2.0
ITP–4	371 E	1180 N	2.5
ITP–5	967 E	1573 N	2.5
ITP–6	1026 E	498 N	2.5
ITP–7	1151 E	756 N	2.5

DYNAMIC CONE PENETRATION TEST (DCPT)		
MARKING	CO-ORDINATES	
DCPT–1	1573 N	1787 E
DCPT–2	1457 N	1907 E
DCPT–3	1298 N	1827 E
DCPT–4	1253 N	1593 E
DCPT–5	1513 N	1643 E
DCPT–6	1619 N	1503 E
DCPT–7	1369 N	1506 E
DCPT–8	1265 N	1448 E
DCPT–9	1585 N	1448 E
DCPT–10	1691 N	1448 E
DCPT–11	1691 N	1371 E
DCPT–12	1372 N	1382 E
DCPT–13	1265 N	1382 E
DCPT–14	1265 N	1222 E
DCPT–15	1301 N	1262 E
DCPT–16	1321 N	1182 E
DCPT–17	1382 N	1185 E
DCPT–18	1407 N	1222 E
DCPT–19	1478 N	1182 E
DCPT–20	1549 N	1222 E
DCPT–21	1575 N	1187 E
DCPT–22	1585 N	1262 E
DCPT–23	1628 N	1182 E
DCPT–24	1691 N	1262 E
DCPT–25	1691 N	1163 E
DCPT–26	1680 N	1117 E
DCPT–27	1559 N	1148 E
DCPT–28	1395 N	1151 E
DCPT–29	1716 N	907 E
DCPT–30	474 N	628 E
DCPT–31	617 N	2086 E
DCPT–32	1422 N	2076 E

ELECTRICAL RESISTIVITY TEST (IERT)		
MARKING	CO-ORDINATES	
IERT–1	1367 E	580 N
IERT–2	1068 E	678 N
IERT–3	1016 E	763 N
IERT–4	585 E	730 N
IERT–5	682 E	1219 N
IERT–6	1330 E	1230 N
IERT–7	955 E	763 N
IERT–8	717 E	1160 N
IERT–9	1054 E	1579 N
IERT–10	1016 E	1499 N

CROSSHOLE SHEAR TEST (CST)		
MARKING	CO-ORDINATES	
CST–1	1616 N	1454 E
CST–2	1460 N	1454 E
CST–3	1314 N	1454 E
CST–4	1336 N	1302 E
CST–5	1407 N	1342 E
CST–6	1549 N	1302 E
CST–7	1620 N	1102 E
CST–8	1478 N	1102 E
CST–9	1336 N	1102 E
CST–10	1325 N	1159 E
CST–11	1478 N	1159 E
CST–12	1628 N	1159 E

PRESSURE METER TEST (IPMT)		
MARKING	CO-ORDINATES	
IPMT–1	1116 E	621 N
IPMT–2	1000 E	557 N
IPMT–3	1127 E	681 N
IPMT–4	1326 E	689 N
IPMT–5	1271 E	738 N
IPMT–6	707 E	1004 N

PRESSURE METER TEST (PMT)		
MARKING	CO-ORDINATES	
PMT–1	1656 N	1448 E
PMT–2	1514 N	1448 E
PMT–3	1372 N	1448 E
PMT–4	1372 N	1342 E
PMT–5	1514 N	1342 E
PMT–6	1656 N	1342 E
PMT–7	1596 N	1168 E
PMT–8	1503 N	1138 E
PMT–9	1293 N	1169 E

CROSS HOLE SHEAR WAVE TEST (ICST)		
MARKING	CO-ORDINATES	
ICST–1	646 E	795 N
ICST–2	1047 E	510 N

ELECTRICAL RESISTIVITY TEST (ERT)		
MARKING	CO-ORDINATES	
ERT–33	1377 N	1116 E
ERT–34	1454 N	1059 E
ERT–35	1541 N	1113 E
ERT–36	1611 N	1059 E
ERT–37	1662 N	1082 E
ERT–38	1570 N	988 E
ERT–39	1392 N	968 E
ERT–40	1296 N	981 E
ERT–41	1656 N	848 E
ERT–42	1510 N	848 E
ERT–43	1408 N	815 E
ERT–44	1445 N	703 E
ERT–45	1505 N	640 E
ERT–46	1438 N	543 E
ERT–47	1384 N	644 E
ERT–48	1298 N	507 E
ERT–49	1272 N	311 E
ERT–50	850 N	841 E
ERT–51	1540 N	1849 E
ERT–52	1476 N	1867 E
ERT–53	1400 N	1867 E
ERT–54	1333 N	1827 E
ERT–55	1560 N	1502 E
ERT–56	1461 N	1502 E
ERT–57	1351 N	1502 E
ERT–58	1643 N	800 E

DYNAMIC CONE PENETRATION TEST (IDCPT)		
MARKING	CO-ORDINATES	
IDCPT–1	1288 E	1215 N
IDCPT–2	747 E	1235 N
IDCPT–3	533 E	1034 N
IDCPT–4	383 E	809 N
IDCPT–5	1153 E	466 N
IDCPT–6	1089 E	510 N
IDCPT–7	1006 E	510 N
IDCPT–8	902 E	498 N
IDCPT–9	922 E	510 N
IDCPT–10	947 E	1459 N
DCPT–11	1246 E	623 N
IDCPT–12	911 E	1316 N
IDCPT–13	737 E	845 N

BORE HOLES (IBH)			DEPTH (M) (REFER NOTE–2)
MARKING	CO-ORDINATES		
IBH 57	943 E	498 N	20
IBH 58	984 E	1459 N	20
IBH 59	882 E	1466 N	20
IBH 60	887 E	1383 N	30
IBH 61	1961 E	1657 N	20
IBH 62	2086 E	1655 N	20
IBH 63	2086 E	1496 N	15
IBH 64	1302 E	1265 N	30
IBH 65	1238 E	1221 N	20
IBH 66	1063 E	1222 N	20
IBH 67	888 E	1088 N	20
IBH 68	1296 E	1564 N	25
IBH 69	1287 E	1402 N	25
IBH 70	992 E	1528 N	20
IBH 71	889 E	711 N	20
IBH 72	889 E	568 N	20
IBH 73	888 E	1221 N	30
IBH 74	888 E	510 N	30
IBH 75	855 E	1321 N	20
IBH 76	829 E	1289 N	20
IBH 77	807 E	1322 N	20
IBH 78	763 E	1289 N	30
IBH 79	956 E	1322 N	30
IBH 80	364 E	1213 N	20
IBH 81	349 E	1150 N	20
IBH 82	756 E	1200 N	20
IBH 83	764 E	1111 N	20
IBH 84	720 E	1061 N	30
IBH 85	764 E	1019 N	20
IBH 86	736 E	948 N	30
IBH 87	720 E	810 N	30
IBH 88	388 E	1120 N	15
IBH 89	373 E	1078 N	20
IBH 90	388 E	1020 N	15
IBH 91	370 E	990 N	15
IBH 92	413 E	970 N	15
IBH 93	363 E	922 N	15
IBH 94	453 E	1139 N	15
IBH 95	453 E	1071 N	15
IBH 96	453 E	1037 N	25
IBH 97	473 E	970 N	15
IBH 98	473 E	902 N	15
IBH 99	453 E	868 N	15
IBH 100	511 E	1173 N	15
IBH 101	531 E	1139 N	15
IBH 102	551 E	1105 N	15
IBH 103	531 E	1071 N	20
IBH 104	511 E	1037 N	15
IBH 105	531 E	1004 N	15
IBH 106	551 E	970 N	15
IBH 107	511 E	936 N	15
IBH 108	531 E	868 N	20
IBH 109	596 E	1139 N	15
IBH 110	596 E	1071 N	15
IBH 111	576 E	1037 N	20
IBH 112	612 E	1017 N	20
IBH 113	616 E	970 N	15
IBH 114	616 E	902 N	15
IBH 115	596 E	868 N	15
IBH 116	405 E	1050 N	15
IBH 117	384 E	957 N	15
IBH 118	396 E	900 N	20

BORE HOLE (BH)			DEPTH (M) (REFER NOTE–2)
MARKING	CO-ORDINATES		
BH–127	1425 N	793 E	20
BH–128	1375 N	822 E	20
BH–129	1421 N	743 E	20
BH–130	1386 N	717 E	30
BH–131	1412 N	717 E	25
BH–132	1432 N	717 E	30
BH–133	1457 N	717 E	25
BH–134	1487 N	720 E	20
BH–135	1534 N	687 E	15
BH–136	1492 N	681 E	15
BH–137	1444 N	677 E	15
BH–138	1382 N	677 E	30
BH–139	1394 N	654 E	25
BH–140	1455 N	639 E	20
BH–141	1525 N	643 E	20
BH–142	1513 N	582 E	20
BH–143	1478 N	589 E	15
BH–144	1428 N	580 E	15
BH–145	1400 N	600 E	20
BH–146	1370 N	612 E	15
BH–147	1301 N	674 E	15
BH–148	1299 N	562 E	20
BH–149	1379 N	534 E	15
BH–150	1445 N	512 E	20
BH–151	1299 N	483 E	15
BH–152	1285 N	406 E	15
BH–153	1274 N	287 E	15
BH–154	1161 N	847 E	15
BH–155	1051 N	830 E	20
BH–156	884 N	853 E	15
BH–157	802 N	853 E	20
BH–158	986 N	897 E	15
BH–159	850 N	925 E	10
BH–160	776 N	1360 E	10
BH–161	1151 N	1425 E	10
BH–162	776 N	1600 E	10
BH–163	779 N	1871 E	10
BH–164	1151 N	1800 E	10
BH–165	1000 N	2056 E	10
BH–166	1152 N	2084 E	10
BH–167	1171 N	2172 E	10
BH–168	1713 N	553 E	15
BH–169	1712 N	1064 E	10
BH–170	1715 N	1233 E	10
BH–171	1715 N	1347 E	15
BH–172	1684 N	1579 E	10
BH–173	1647 N	1802 E	10
BH–174	1282 N	2073 E	15
BH–175	1193 N	2315 E	10
BH–176	854 N	2415 E	15
BH–177	706 N	2210 E	10
BH–178	521 N	1955 E	10
BH–179	436 N	1690 E	15
BH–180	445 N	1379 E	10
BH–181	464 N	808 E	10
BH–182	472 N	480 E	10
BH–183	466 N	216 E	15
BH–184	731 N	188 E	10
BH–185	963 N	351 E	10
BH–186	1145 N	283 E	10
BH–187	1361 N	487 E	10
BH–188	1588 N	381 E	15
BH–189	1679 N	835 E	20
BH–190	1224 N	1473 E	20
BH–191	1581 N	1697 E	10
BH–192	1481 N	1697 E	15
BH–193	1359 N	1697 E	10
BH–194	1538 N	1775 E	15

BORE HOLES (IBH)			DEPTH (M) (REFER NOTE–2)
MARKING	CO-ORDINATES		
IBH 1	1193 E	622 N	30
IBH 2	1000 E	623 N	30
IBH 3	1213 E	562 N	30
IBH 4	1116 E	554 N	30
IBH 5	1109 E	675 N	30
IBH 6	1168 E	698 N	30
IBH 7	1105 E	656 N	30
IBH 8	1200 E	738 N	20
IBH 9	1326 E	623 N	30
IBH 10	1319 E	557 N	30
IBH 11	1319 E	738 N	30
IBH 12	1109 E	738 N	30
IBH 13	652 E	743 N	30
IBH 14	653 E	1236 N	30
IBH 15	1317 E	1244 N	30
IBH 16	1300 E	1231 N	30
IBH 17	571 E	815 N	30
IBH 18	428 E	815 N	30
IBH 19	428 E	1236 N	30
IBH 20	571 E	1236 N	20
IBH 21	801 E	738 N	30
IBH 22	651 E	964 N	20
IBH 23	653 E	1116 N	20
IBH 24	975 E	1230 N	20
IBH 25	1149 E	1231 N	20
IBH 26	505 E	815 N	20
IBH 27	428 E	937 N	20
IBH 28	433 E	1173 N	20
IBH 29	572 E	937 N	20
IBH 30	576 E	1173 N	20
IBH 31	507 E	1235 N	20
IBH 32	371 E	873 N	20
IBH 33	473 E	1105 N	15
IBH 34	616 E	1105 N	15
IBH 35	453 E	1004 N	20
IBH 36	551 E	902 N	15
IBH 37	645 E	817 N	30
IBH 38	664 E	879 N	20
IBH 39	1353 E	573 N	20
IBH 40	1062 E	667 N	30
IBH 41	992 E	753 N	30
IBH 42	607 E	730 N	20
IBH 43	687 E	1209 N	30
IBH 44	1360 E	1230 N	20
IBH 45	951 E	748 N	20
IBH 46	721 E	1173 N	20
IBH 47	879 E	738 N	20
IBH 48	723 E	738 N	20
IBH 49	732 E	882 N	20
IBH 50	327 E	1284 N	20
IBH 51	1163 E	492 N	15
IBH 52	1012 E	1573 N	20
IBH 53	1030 E	1506 N	20
IBH 54	1068 E	498 N	20
IBH 55	985 E	498 N	20
IBH 56	984 E	511 N	20

BORE HOLE (BH)			DEPTH (M) (REFER NOTE–2)
MARKING	CO-ORDINATES		
BH–1	1573 N	1907 E	15
BH–2	1573 N	1827 E	10
BH–3	1505 N	1827 E	15
BH–4	1505 N	1867 E	10
BH–5	1437 N	1867 E	15
BH–6	1425 N	1775 E	10
BH–7	1369 N	1827 E	15
BH–8	1369 N	1867 E	10
BH–9	1298 N	1907 E	15
BH–10	1281 N	1775 E	10
BH–11	1253 N	1643 E	30
BH–12	1318 N	1643 E	25
BH–13	1383 N	1643 E	30
BH–14	1383 N	1593 E	25
BH–15	1448 N	1643 E	30
BH–16	1513 N	1593 E	30
BH–17	1578 N	1643 E	30
BH–18	1643 N	1643 E	25
BH–19	1643 N	1593 E	30
BH–20	1615 N	1534 E	30
BH–21	1585 N	1504 E	25
BH–22	1511 N	1502 E	30
BH–23	1480 N	1534 E	25
BH–24	1429 N	1526 E	30
BH–25	1371 N	1534 E	25
BH–26	1311 N	1533 E	30
BH–27	1311 N	1499 E	25
BH–28	1253 N	1543 E	30
BH–29	1236 N	1534 E	25
BH–30	1250 N	1448 E	25
BH–31	1265 N	1469 E	30
BH–32	1265 N	1426 E	25
BH–33	1301 N	1426 E	30
BH–34	1305 N	1454 E	30
BH–35	1336 N	1454 E	30
BH–36	1372 N	1469 E	25
BH–37	1372 N	1426 E	30
BH–38	1425 N	1426 E	25
BH–39	1443 N	1426 E	30
BH–40	1429 N	1454 E	25
BH–41	1451 N	1454 E	30
BH–42	1478 N	1426 E	25
BH–43	1482 N	1454 E	30
BH–44	1514 N	1469 E	25
BH–45	1514 N	1426 E	30
BH–46	1549 N	1426 E	25
BH–47	1549 N	1469 E	25
BH–48	1585 N	1469 E	25
BH–49	1585 N	1426 E	30
BH–50	1607 N	1454 E	30
BH–51	1639 N	1454 E	30
BH–52	1656 N	1426 E	25
BH–53	1656 N	1469 E	30
BH–54	1691 N	1469 E	25
BH–55	1691 N	1426 E	30
BH–56	1691 N	1302 E	30
BH–57	1656 N	1302 E	25
BH–58	1620 N	1342 E	30
BH–59	1620 N	1382 E	25
BH–60	1585 N	1342 E	25
BH–61	1585 N	1302 E	30
BH–62	1549 N	1342 E	25
BH–63	1549 N	1382 E	25
BH–64	1514 N	1382 E	25
BH–65	1514 N	1302 E	30
BH–66	1478 N	1302 E	30
BH–67	1478 N	1342 E	30
BH–68	1478 N	1382 E	25
BH–69	1443 N	1342 E	25
BH–70	1407 N	1382 E	30
BH–71	1372 N	1302 E	30
BH–72	1336 N	1342 E	30
BH–73	1336 N	1382 E	25
BH–74	1297 N	1345 E	25
BH–75	1239 N	1395 E	20
BH–76	1265 N	1262 E	25
BH–77	1301 N	1222 E	25
BH–78	1336 N	1262 E	25
BH–79	1372 N	1222 E	30
BH–80	1449 N	1262 E	25
BH–81	1478 N	1222 E	30
BH–82	1514 N	1262 E	25
BH–83	1549 N	1262 E	25
BH–84	1585 N	1222 E	30
BH–85	1620 N	1262 E	25
BH–86	1656 N	1262 E	25
BH–87	1691 N	1222 E	25
BH–88	1671 N	1098 E	25
BH–89	1660 N	1168 E	25
BH–90	1646 N	1059 E	30
BH–91	1628 N	1059 E	30
BH–92	1619 N	1044 E	30
BH–93	1619 N	1074 E	30
BH–94	1600 N	1112 E	25
BH–95	1596 N	1138 E	25
BH–96	1563 N	1062 E	30
BH–97	1549 N	1129 E	25
BH–98	1532 N	1064 E	20
BH–99	1503 N	1169 E	25
BH–100	1489 N	1059 E	30
BH–101	1471 N	1059 E	30
BH–102	1463 N	1044 E	30
BH–103	1463 N	1073 E	30
BH–104	1439 N	1138 E	25
BH–105	1442 N	1113 E	25
BH–106	1435 N	1038 E	30
BH–107	1393 N	1039 E	20
BH–108	1386 N	1133 E	25
BH–109	1357 N	1168 E	25
BH–110	1352 N	1109 E	30
BH–111	1343 N	1059 E	30
BH–112	1325 N	1059 E	30
BH–113	1317 N	1044 E	30
BH–114	1317 N	1073 E	30
BH–115	1301 N	1109 E	25
BH–116	1293 N	1138 E	25
BH–117	1285 N	987 E	20
BH–118	1338 N	990 E	20
BH–119	1387 N	979 E	20
BH–120	1645 N	962 E	15
BH–121	1697 N	973 E	15
BH–122	1704 N	939 E	15
BH–123	1663 N	819 E	25
BH–124	1616 N	840 E	20
BH–125	1608 N	803 E	20
BH–126	1498 N	827 E	15

CUSTOMER: NTPC LIMITED

3x800MW PATRATU SUPER THERMAL POWER PROJECT

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA

JOB NO. 434
STATUS CONTRACT
DISTRIBUTION

REV.	DATE	ALTD	CHD	APPD
02	29.01.2018	PPK	–SD–	–SD–
01	20.01.2018	–SD–	–SD–	–SD–

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	DESN	PK	–SD–	29.01.2018
	CHD	AKV/NSR	–SD–	29.01.2018
	APPD	CPK	–SD–	29.01.2018

TITLE: GEOTECHNICAL INVESTIGATION LAYOUT OF PLANT AREA

DEPT. | SCALE 1x05 | DRAWING NO. PE-DG-434-602-C001
SIGN | SHEET 1 OF 1 | REV. 02
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2. FIELD INVESTIGATION

2.01. GENERAL:

In an attempt for finalisation in the design of foundation for these proposed structures to be constructed at this site, Geotechnical Investigation was envisaged. The entire Investigation programme had been divided mainly into two parts, I) Field works & II) Laboratory tests.

I) Field works unfold the sub-surface deposit types and their characteristics and

II) Laboratory tests part would help determining the relevant physical and geotechnical properties of the sub-surface deposits leading to finalisation of foundation depths of the structures and the bearing capacity with particular reference to the sub-surface types and their strength parameters and settlement potentials at the site.

A list of the bore holes with the location, ground level, standing water level etc. are presented in a tabular form below:-

Name of the Structure	Borehole No.	Co-ordinate (M)		E.G.L. (M)	Terminating Depth (M)	S.W.L. (M)	Top of rock below EGL (M)
		Easting	Northing				
Switch Yard	BH-1	1907	1573	366.373	15.00	1.20	7.00
	BH-2	1827	1573	367.123	10.00	1.05	5.50
	BH-3	1827	1505	367.709	15.00	0.30	1.50
	BH-4	1867	1505	366.592	10.00	0.20	0.00
	BH-5	1867	1437	367.184	15.00	2.80	6.00
Tower/Gantries Between Switch Yard and ACC	BH-6	1775	1425	371.145	10.00	1.80	2.80
Switch Yard	BH-7	1827	1369	367.589	15.00	0.30	3.00
	BH-8	1867	1369	369.156	10.00	2.30	2.75
	BH-9	1907	1298	373.075	15.00	0.90	4.00
Tower/Gantries Between Switch Yard and ACC	BH-10	1775	1281	372.598	10.00	1.40	3.20
Transformer Yard & ACC Area#1	BH-11	1643	1253	374.215	30.00	3.90	3.80
	BH-12	1643	1318	373.879	25.00	4.10	5.25
	BH-13	1643	1383	373.769	30.00	2.30	16.00
	BH-14	1593	1383	371.416	25.00	2.50	2.50
Transformer Yard & ACC Area#2	BH-15	1643	1448	370.809	30.00	0.80	9.70
	BH-16	1593	1513	374.852	30.00	0.60	11.50
Transformer Yard & ACC Area#3	BH-17	1643	1578	373.672	30.00	1.10	3.50
	BH-18	1643	1643	372.341	25.00	0.30	2.50
	BH-19	1593	1643	373.740	30.00	0.40	3.70
	BH-20	1534	1615	376.723	30.00	3.50	1.90
	BH-21	1504	1585	377.683	25.00	3.60	3.50
Transformer Yard & ACC Area#2	BH-22	1502	1511	377.818	30.00	4.80	4.50
	BH-23	1534	1480	377.227	25.00	5.20	3.50
	BH-24	1526	1429	377.587	30.00	6.10	3.25
Transformer Yard & ACC Area#1	BH-25	1534	1371	371.397	25.00	1.20	2.30
	BH-26	1533	1311	377.088	30.00	4.60	2.00
	BH-27	1499	1311	378.380	25.00	5.10	3.00
	BH-28	1543	1253	376.598	30.00	5.70	4.75

Name of the Structure	Borehole No.	Co-ordinate (M)		E.G.L. (M)	Terminating Depth (M)	S.W.L. (M)	Top of rock below EGL (M)
		Easting	Northing				
DG Building	BH-29	1534	1236	376.049	25.00	4.30	3.30
Service Building	BH-30	1448	1250	377.709	25.00	4.70	3.25
Power House Area #1	BH-31	1469	1265	378.187	30.00	4.80	2.75
	BH-32	1426	1265	378.337	25.00	4.60	3.50
	BH-33	1426	1301	379.581	30.00	10.70	2.80
	BH-34	1454	1305	379.660	30.00	10.30	2.00
	BH-35	1454	1336	374.274	30.00	1.70	2.00
	BH-36	1469	1372	381.663	25.00	7.80	2.50
	BH-37	1426	1372	381.086	30.00	8.10	3.30
	BH-38	1426	1407	380.339	25.00	10.40	3.00
Power House Area #2	BH-39	1426	1443	380.866	30.00	9.20	2.00
	BH-40	1454	1429	380.009	25.00	11.00	3.00
	BH-41	1454	1451	379.992	30.00	9.50	1.50
	BH-42	1426	1478	379.850	25.00	8.30	1.50
	BH-43	1454	1482	379.902	30.00	8.70	4.80
	BH-44	1469	1514	379.357	25.00	8.60	3.00
	BH-45	1426	1514	379.652	30.00	9.10	1.60
Power House Area #3	BH-46	1426	1549	382.898	25.00	9.15	2.70
	BH-47	1469	1549	379.091	25.00	9.05	3.50
	BH-48	1469	1585	379.048	25.00	9.90	3.50
	BH-49	1426	1585	380.701	30.00	10.20	2.50
	BH-50	1454	1607	379.241	30.00	4.20	3.20
	BH-51	1454	1639	379.209	30.00	4.05	6.00
	BH-52	1426	1656	380.332	25.00	4.10	6.50
	BH-53	1469	1656	378.576	30.00	4.00	6.00
	BH-54	1469	1691	377.673	25.00	2.80	6.00
	BH-55	1426	1691	380.029	30.00	4.20	5.80
Mill Bunker Area #3	BH-56	1302	1691	381.809	30.00	3.70	4.50
	BH-57	1302	1656	381.691	25.00	3.00	6.00
Boiler Area #3	BH-58	1342	1620	381.985	30.00	4.80	4.50
	BH-59	1382	1620	381.374	25.00	5.10	3.50
	BH-60	1342	1585	382.908	25.00	8.70	3.50
Mill Bunker Area #3	BH-61	1302	1585	383.631	30.00	8.60	7.00
Boiler Area #3	BH-62	1342	1549	382.409	25.00	7.30	3.60
Power House Area #3	BH-63	1382	1549	382.568	25.00	7.80	2.50
Boiler #2	BH-64	1382	1514	382.111	25.00	8.40	3.50
Mill Bunker #2	BH-65	1302	1514	382.423	30.00	9.50	4.30
	BH-66	1302	1478	381.460	30.00	8.80	2.30
Boiler #2	BH-67	1342	1478	382.209	30.00	9.70	3.00
	BH-68	1382	1478	381.844	25.00	10.05	4.00
	BH-69	1342	1443	381.689	25.00	9.20	3.00
	BH-70	1382	1407	381.982	30.00	9.80	3.00
Mill Bunker #1	BH-71	1302	1372	377.622	30.00	4.50	1.50
Boiler #1	BH-72	1342	1336	381.082	30.00	9.50	2.60
	BH-73	1382	1336	379.325	25.00	9.20	1.20

Name of the Structure	Borehole No.	Co-ordinate (M)		E.G.L. (M)	Terminating Depth (M)	S.W.L. (M)	Top of rock below EGL (M)
		Easting	Northing				
Boiler #1	BH-74	1345	1297	376.945	25.00	8.80	1.70
Compressor House	BH-75	1395	1239	378.293	20.00	4.70	3.50
ESP #1	BH-76	1262	1265	375.906	25.00	2.40	3.80
	BH-77	1222	1301	373.467	25.00	2.70	1.50
	BH-78	1262	1336	375.387	25.00	2.50	3.25
	BH-79	1222	1372	378.151	30.00	4.30	5.50
ESP #2	BH-80	1262	1449	378.375	25.00	3.70	2.80
	BH-81	1222	1478	380.314	30.00	4.20	5.00
	BH-82	1262	1514	380.537	25.00	9.70	2.70
ESP #3	BH-83	1262	1549	382.056	25.00	6.30	2.50
	BH-84	1222	1585	383.515	30.00	7.20	4.35
	BH-85	1262	1620	384.934	25.00	8.10	3.70
	BH-86	1262	1656	384.183	25.00	7.90	4.00
	BH-87	1222	1691	384.878	25.00	8.20	4.50
ESP Control Room #3	BH-88	1098	1671	382.487	25.00	2.80	2.70
ID Fan #3	BH-89	1168	1660	383.036	25.00	4.10	3.00
Chimney #3	BH-90	1059	1646	379.562	30.00	3.00	1.60
	BH-91	1059	1628	380.017	30.00	2.50	3.60
	BH-92	1044	1619	378.865	30.00	1.80	2.90
	BH-93	1074	1619	379.557	30.00	2.80	1.40
FGD - Absorber #3	BH-94	1112	1600	380.886	25.00	6.90	2.60
ID Fan #3	BH-95	1138	1596	381.280	25.00	7.10	2.70
FGD C. Room #3	BH-96	1062	1563	379.398	30.00	2.10	2.80
ESP Control Room #2	BH-97	1129	1549	379.807	25.00	6.80	2.60
Air Cooled Chiller & Pump House Area	BH-98	1064	1532	377.524	20.00	2.30	2.60
ID Fan #2	BH-99	1169	1503	380.539	25.00	4.60	3.40
Chimney #2	BH-100	1059	1489	376.932	30.00	3.10	4.00
	BH-101	1059	1471	376.075	30.00	3.20	3.60
	BH-102	1044	1463	375.464	30.00	2.80	2.40
	BH-103	1073	1463	377.155	30.00	3.00	2.50
ID Fan #2	BH-104	1138	1439	376.470	25.00	4.60	3.30
FGD - Absorber #2	BH-105	1113	1442	377.209	25.00	3.80	2.00
FGD C. Room #2	BH-106	1038	1435	374.230	30.00	1.10	1.80
Waste Water & Sec. Hydro Cyclone Feed Tanks, Waste water tank, Filtrate water tank and pumps area	BH-107	1039	1393	373.806	20.00	1.30	0.20
ESP Control Room #1	BH-108	1133	1386	375.833	25.00	2.60	2.60
ID Fan #1	BH-109	1168	1357	377.280	25.00	2.80	3.50
FGD C. Room #1	BH-110	1109	1352	374.225	30.00	2.50	1.50
Chimney #1	BH-111	1059	1343	371.918	30.00	0.40 m above EGL	2.00
	BH-112	1059	1325	372.512	30.00	0.50 m above EGL	2.50

Name of the Structure	Borehole No.	Co-ordinate (M)		E.G.L. (M)	Terminating Depth (M)	S.W.L. (M)	Top of rock below EGL (M)
		Easting	Northing				
Chimney #1	BH-113	1044	1317	372.694	30.00	0.60 m above EGL	1.75
	BH-114	1073	1317	372.273	30.00	0.20 m above EGL	2.50
FGD - Absorber #1	BH-115	1109	1301	374.711	25.00	2.80	3.80
ID Fan #1	BH-116	1138	1293	375.161	25.00	2.80	3.50
Limestone Grinding Bld.	BH-117	987	1285	374.854	20.00	2.70	3.50
Aux. Boiler	BH-118	990	1338	372.809	20.00	0.30	2.50
LHP-GYPSU, Dewatering Buliding	BH-119	979	1387	374.120	20.00	1.20	2.90
Canteen	BH-120	962	1645	378.225	15.00	0.35	2.70
Safety Park	BH-121	973	1697	382.463	15.00	6.80	6.50
Time Office	BH-122	939	1704	381.870	15.00	3.40	7.00
Admin Building	BH-123	819	1663	382.428	25.00	4.40	4.50
IT Buliding	BH-124	840	1616	382.138	20.00	4.70	3.50
Auditorium	BH-125	803	1608	382.367	20.00	4.30	3.80
Owner's Office	BH-126	827	1498	379.209	15.00	3.10	4.00
Fire Water Tank & Pump house & FQA Building Area	BH-127	793	1425	376.709	20.00	4.40	5.80
Fire Station Building & Drill Tower Area	BH-128	822	1375	375.167	20.00	0.20	3.20
ACWPH	BH-129	743	1421	376.898	20.00	1.20	5.00
ACW Cooling Tower	BH-130	717	1386	378.140	30.00	3.10	3.50
	BH-131	717	1412	377.109	25.00	4.30	6.80
	BH-132	717	1432	379.626	30.00	3.00	5.40
	BH-133	717	1457	377.801	25.00	3.20	3.00
ClO_2 Dosing System	BH-134	720	1487	379.598	20.00	2.90	3.00
Chemical Lab	BH-135	687	1534	380.842	15.00	3.50	3.00
Chemical Storage	BH-136	681	1492	378.598	15.00	2.50	3.50
ACW Treat. System	BH-137	677	1444	377.692	15.00	2.40	2.80
CPU Regn.	BH-138	677	1382	379.198	30.00	3.30	1.40
	BH-139	654	1394	378.809	25.00	3.10	3.70
RO-DM Plant & N Pit Area	BH-140	639	1455	377.701	20.00	1.80	3.50
	BH-141	643	1525	380.187	20.00	4.30	4.30
PT Plant & Clarified Water Reservoir Area	BH-142	582	1513	379.198	20.00	0.90	3.00
	BH-143	589	1478	378.530	15.00	0.70	2.50
	BH-144	580	1428	378.798	15.00	1.90	3.30
DM Water Tank & Pump House Area	BH-145	600	1400	380.161	20.00	3.70	3.80
	BH-146	612	1370	380.409	15.00	3.90	3.30
ZLD for FGD	BH-147	674	1301	381.203	15.00	4.30	1.40
O & M Stores	BH-148	562	1288	384.809	20.00	3.20	3.50
Make-up Water Tank & Pump House Area	BH-149	534	1379	382.784	15.00	3.25	3.25
PT Plant & Clarified Water Reservoir Area	BH-150	512	1445	380.687	20.00	2.20	3.20

Name of the Structure	Borehole No.	Co-ordinate (M)		E.G.L. (M)	Terminating Depth (M)	S.W.L. (M)	Top of rock below EGL (M)
		Easting	Northing				
Workshop	BH-151	483	1299	385.287	15.00	3.10	3.00
Owner's Stores	BH-152	406	1285	387.603	15.00	2.30	2.60
STP	BH-153	287	1274	388.689	15.00	4.20	3.00
Stores (Construction)	BH-154	847	1161	377.405	15.00	4.30	6.40
Ammonia Storage	BH-155	830	1051	374.709	20.00	4.70	2.60
Foam PH	BH-156	853	884	373.881	15.00	4.10	4.50
Fuel Oil Pump House	BH-157	853	802	374.389	20.00	3.70	4.50
Boundary Wall for Exixting Plant Area	BH-158	897	986	373.709	15.00	3.90	3.60
	BH-159	925	850	373.682	10.00	5.80	2.25
	BH-160	1360	776	374.368	10.00	5.70	6.00
	BH-161	1425	1151	374.139	10.00	6.70	4.60
	BH-162	1600	776	373.821	10.00	5.50	6.50
	BH-163	1871	779	372.655	10.00	6.20	6.50
	BH-164	1800	1151	374.840	10.00	3.20	3.60
	BH-165	2056	1000	373.867	15.00	4.70	4.70
	BH-166	2084	1152	374.792	10.00	5.30	4.00
H_2 Generation Plant	BH-167	2172	1171	369.451	15.00	4.50	3.75
Proposed Plant Boundary	BH-168	553	1713	385.580	15.00	4.40	3.50
	BH-169	1064	1712	382.909	10.00	4.70	3.50
	BH-170	1233	1715	384.709	10.00	7.00	4.30
	BH-171	1347	1715	382.121	15.00	4.40	5.50
	BH-172	1579	1684	375.167	10.00	1.00	5.80
	BH-173	1802	1647	369.890	10.00	1.10	8.80
	BH-174	2073	1282	370.455	15.00	3.20	6.00
	BH-175	2315	1193	368.925	10.00	8.30	6.40
	BH-176	2415	854	365.224	15.00	12.50	6.20
	BH-177	2210	706	366.072	10.00	Not found	5.70
	BH-178	1955	521	363.583	10.00	Not found	6.30
	BH-179	1690	436	369.525	15.00	Not found	6.10
	BH-180	1379	445	365.832	10.00	Not found	6.20
	BH-181	808	464	373.194	10.00	Not found	6.50
	BH-182	480	472	371.835	10.00	2.40	2.00
	BH-183	216	466	374.054	15.00	Not found	3.00
	BH-184	188	731	383.189	10.00	6.50	3.50
	BH-185	331	963	383.830	10.00	Not found	6.00
	BH-186	283	1145	386.603	10.00	6.20	5.00
	BH-187	487	1361	384.708	10.00	2.80	4.00
	BH-188	381	1588	385.090	15.00	3.90	3.80
Admin Building	BH-189	835	1679	382.389	20.00	4.90	5.00
E Pit & S Pit Area	BH-190	1473	1224	377.387	20.00	4.20	3.50
Tower/Gantries Between Switch Yard and ACC	BH-191	1697	1581	370.231	10.00	1.05	2.10
	BH-192	1697	1481	370.087	15.00	2.10	11.25
	BH-193	1697	1359	373.167	10.00	3.70	6.30
	BH-194	1775	1538	368.534	15.00	0.90	11.10

Additionally the following test locations which are located close to the boundary wall are also considered for recommendation on boundary wall.

Bore Hole No.	Co-ordinate, (M)		G.L. (M)	Terminating Depth (M)	Standing Water Level (M)	Top of rock below EGL (M)
	Easting	Northing				
IBH-24	975	1230	375.183	20.00	3.80	4.75
IBH-25	1149	1231	374.069	20.00	2.70	3.00
IBH-44	1360	1230	376.330	20.00	4.00	3.50
IBH-61	1961	1657	369.587	20.00	3.00	10.00
IBH-62	2086	1655	364.465	20.00	2.60	6.00
IBH-63	2086	1496	363.540	15.00	2.20	6.50
IBH-65	1238	1221	374.289	20.00	2.20	4.00
IBH-66	1063	1222	374.457	20.00	2.30	5.00
IBH-67	888	1088	374.478	20.00	4.50	1.60
IBH-73	888	1221	375.739	30.00	4.10	3.40

Note: BH-121 & 122 are also considered here due to its proximity to boundary wall

2.02. BORING:

Boring was carried out by Shell and Auger method to sink nominal 150mm diameter bore holes to depths envisaged by using a mechanical winch. Undisturbed soil samples were collected at suitable intervals or at change of strata whichever is earlier by open drive sampling method since it was intended to ascertain the sub-soil characteristics.

2.03. SAMPLING:

Nominal 100 mm diameter undisturbed samples were recovered. The sampling equipment used consists of a two-tier assembly of sample tubes 450 mm in length fitted at its lower end. The sampling assembly was driven by means of a jarring link to its full length or as far downs as was found practicable. As the soil is very stiff to hard and contains sand mixtures / calcareous nodules, cutting shoe was used with a area ratio < 20%. After withdrawal the ends of the tubes were sealed with wax and capped before onward transmission to the laboratory. At close intervals in depth disturbed samples were collected for identification and logging purpose. These were tagged and packed in polythene packets and transported to the laboratory.

2.04. STANDARD PENETRATION TESTS:

Standard Penetration Tests were conducted in the bore holes at intervals of 1.5M to 3.0M depth or at change of strata whichever is earlier using a split spoon sampler. The split spoon sampler used is of a Standard design having an outer diameter of 50.8 mm and inner diameter of 35 mm, driven with a monkey weighing 63.5 kgs, falling freely through 75cms. A record of the number of blows required to penetrate every 15cms to a maximum depth of 45cms was

made. The first 15cm of drive are considered to be seating drive and are neglected. The total blows required for second & third 15cm of penetration is counted and termed as penetration resistance "N". On completion of a test, the split spoon sampler was opened and soil specimens were preserved in polythene bags for logging purpose.

All the boreholes were sunk with winch. However, raising of hammer for SP Tests were done manually. Hence there will not be any inertia loss and the efficiency of hammer blows should be considered as 100%.

2.05. MEASUREMENT OF WATER TABLE:

Standing water level after 24 hours of removal of casing was also noted and shown in the profile.

2.06. ROTARY CORE DRILLING:

This drilling technique is regarded as the most satisfactory method of assessing the character of rock formations, which lie at depth below the ground surface. Specimens of rock in the form of cylindrical cores are recovered from the drill holes by means of a core barrel. Double barrel technique is adopted according to field condition. The core barrel is provided at its lower end with a detachable shoe or core bit, which is of diamond. All rotary core bits were of NX (73mm) size.

2.07. TRIAL PITS:

33 nos. Trial Pits were excavated for physical verification of subsoil with depth. The co-ordinate and ground level of the Trial Pit locations are presented below.

Trial Pit No.	Co-ordinate (M)		E.G.L. (M)	Depth (M)	Standing Water Level (M)
	Easting	Northing			
TP-01	1846	1472	368.580	4.00	Not Found
TP-02	1617	1429	374.042	4.00	Not Found
TP-03	1521	1667	375.611	4.00	Not Found
TP-04	1501	1480	377.898	4.00	Not Found
TP-05	1469	1407	379.476	4.00	Not Found
TP-06	1426	1336	372.145	4.00	Not Found
TP-07	1426	1620	380.241	4.00	Not Found
TP-08	1317	1672	381.809	4.00	Not Found
TP-09	1317	1501	382.355	4.00	Not Found
TP-10	1317	1359	378.065	4.00	Not Found
TP-11	1222	1336	378.154	4.00	Not Found
TP-12	1222	1445	378.953	4.00	Not Found
TP-13	1222	1620	383.765	4.00	Not Found
TP-14	1093	1597	380.265	4.00	Not Found
TP-15	1089	1425	373.791	4.00	Not Found
TP-16	1089	1281	373.961	4.00	Not Found
TP-17	816	812	374.073	4.00	Not Found

Trial Pit No.	Co-ordinate (M)		E.G.L. (M)	Depth (M)	Standing Water Level (M)
	Easting	Northing			
TP-18	1570	1559	375.598	4.00	Not Found
TP-19	1600	1286	375.284	4.00	Not Found
TP-20	1454	1628	379.285	4.00	Not Found
TP-21	1454	1471	379.344	4.00	Not Found
TP-22	1454	1325	378.587	4.00	Not Found
TP-23	1302	1300	373.559	4.00	Not Found
TP-24	1302	1443	380.305	4.00	Not Found
TP-25	1302	1620	382.015	4.00	Not Found
TP-26	1138	1660	381.567	4.00	Not Found
TP-27	1169	1439	378.467	4.00	Not Found
TP-28	1138	1357	375.595	4.00	Not Found
TP-29	1006	1275	373.891	4.00	Not Found
TP-30	1001	1379	373.064	4.00	Not Found
TP-31	720	1716	384.064	4.00	Not Found
TP-32	1031	442	368.969	4.00	Not Found
TP-33	2422	1014	369.854	4.00	Not Found

2.08. PLATE LOAD TESTS:

Total thirty (30) sets of Plate Load Tests were conducted **using a 450mm or 600mm square plate** (seventeen nos. tests are of routine type & rest thirteen nos. are of cyclic type). Tests are continued upto a maximum desired loading intensity or specified plate settlement which ever is earlier. The load is applied through a hydraulic jack. The reaction for applying the load on the plate is obtained by a loading platform with sandbags. After applying the load increments, settlement records are made at intervals of 1, 2.25, 4, 6.25, 9, 16, 25, 60, 90 & 120 minutes and thereafter at an interval of an hour. When the rate of plate settlement reduced to 0.02 mm per minute, the final readings of the dial gauges is recorded. The coordinate, ground level and depth of test locations are given below.

PLT No.	Type of Tests	Plate size (mm x mm)	Co-ordinates (M)		Ground Level (M)	Depth (M)
			Easting	Northing		
PLT-01	Routine Type	450 x 450	1846	1472	368.580	3.00
PLT-02	Routine Type	600 x 600	1617	1429	374.042	3.00
PLT-03	Routine Type	600 x 600	1521	1667	375.611	3.00
PLT-04	Routine Type	450 x 450	1501	1480	377.898	3.00
PLT-05	Routine Type	450 x 450	1469	1407	379.476	3.00
PLT-06	Routine Type	450 x 450	1426	1336	372.145	3.00
PLT-07	Routine Type	600 x 600	1426	1620	380.241	3.00
PLT-08	Routine Type	450 x 450	1317	1672	381.809	3.00
PLT-09	Routine Type	450 x 450	1317	1501	382.355	3.00
PLT-10	Routine Type	450 x 450	1317	1359	378.065	3.00
PLT-11	Routine Type	450 x 450	1222	1336	378.154	3.00
PLT-12	Routine Type	450 x 450	1222	1445	378.953	3.00
PLT-13	Routine Type	450 x 450	1222	1620	383.765	3.00
PLT-14	Routine Type	450 x 450	1093	1597	380.265	3.00
PLT-15	Routine Type	450 x 450	1089	1425	373.791	3.00
PLT-16	Routine Type	450 x 450	1089	1281	373.961	3.00
PLT-17	Routine Type	450 x 450	816	812	374.073	3.00

PLT No.	Type of Tests	Plate size (mm x mm)	Co-ordinates (M)		Ground Level (M)	Depth (M)
			Easting	Northing		
CPLT-18	Cyclic Type	600 x 600	1570	1559	375.598	3.00
CPLT-19	Cyclic Type	600 x 600	1600	1286	375.284	3.00
CPLT-20	Cyclic Type	600 x 600	1454	1628	379.285	3.00
CPLT-21	Cyclic Type	450 x 450	1454	1471	379.344	3.00
CPLT-22	Cyclic Type	450 x 450	1454	1325	378.587	3.00
CPLT-23	Cyclic Type	450 x 450	1302	1300	373.559	3.00
CPLT-24	Cyclic Type	450 x 450	1302	1443	380.305	3.00
CPLT-25	Cyclic Type	450 x 450	1302	1620	382.015	3.00
CPLT-26	Cyclic Type	450 x 450	1138	1660	381.567	3.00
CPLT-27	Cyclic Type	450 x 450	1169	1439	378.467	3.00
CPLT-28	Cyclic Type	450 x 450	1138	1357	375.595	3.00
CPLT-29	Cyclic Type	600 x 600	1006	1275	373.891	3.00
CPLT-30	Cyclic Type	450 x 450	1001	1379	373.064	3.00

2.09. DYNAMIC CONE PENETRATION TESTS:

Total thirty two (32 nos.) Dynamic Cone Penetration Tests were conducted at the following locations. The co-ordinates, ground level and depth of test at each DCPT locations are presented below. The DCPT values vs. depth plots are presented in Volume-2 (Part IA).

DCPT No.	Co-ordinate (M)		E.G.L. (M)	Depth (M)	
	Easting	Northing		Starting depth	Ending Depth
DCPT-1	1787	1573	368.798	0.00	6.80
DCPT-2	1907	1437	366.605	0.00	5.90
DCPT-3	1827	1298	371.645	0.00	4.10
DCPT-4	1593	1253	375.632	0.00	3.60
DCPT-5	1643	1513	372.671	0.00	5.40
DCPT-6	1503	1619	377.734	0.00	3.50
DCPT-7	1506	1369	374.855	0.00	1.40
DCPT-8	1448	1265	378.903	0.00	3.00
DCPT-9	1448	1585	379.526	0.00	2.00
DCPT-10	1,448	1691	378.101	0.00	5.70
DCPT-11	1371	1691	381.571	0.00	5.10
DCPT-12	1382	1372	381.162	0.00	2.40
DCPT-13	1382	1265	378.368	0.00	2.70
DCPT-14	1222	1265	374.198	0.00	3.50
DCPT-15	1262	1301	375.874	0.00	3.90
DCPT-16	1182	1321	376.175	0.00	3.00
DCPT-17	1185	1382	377.282	0.00	4.20
DCPT-18	1222	1407	378.303	0.00	3.30
DCPT-19	1182	1478	380.078	0.00	3.00
DCPT-20	1222	1549	382.638	0.00	3.20
DCPT-21	1187	1575	382.709	0.00	4.20
DCPT-22	1262	1585	384.279	0.00	5.60
DCPT-23	1182	1628	383.398	0.00	2.60
DCPT-24	1262	1691	384.892	0.00	3.90
DCPT-25	1163	1691	383.613	0.00	3.90
DCPT-26	1117	1680	382.809	0.00	3.30
DCPT-27	1148	1559	380.950	0.00	2.30

DCPT No.	Co-ordinate (M)		E.G.L. (M)	Depth (M)	
	Easting	Northing		Starting depth	Ending Depth
DCPT-28	1151	1395	376.426	0.00	2.30
DCPT-29	907	1716	382.101	0.00	5.00
DCPT-30	628	474	370.121	0.00	6.50
DCPT-31	2086	617	365.355	0.00	6.20
DCPT-32	2076	1422	360.768	0.00	5.10

Additionally the following test locations which are located close to the boundary wall are also considered for recommendation on boundary wall.

DCPT No.	Co-ordinate (M)		E.G.L. (M)	Depth (M)	
	Easting	Northing		Starting depth	Ending Depth
IDCPT-01	1288	1215	374.878	0.00	3.00
IDCPT-05	1153	466	369.084	0.00	6.30

2.10. FIELD PERMEABILITY TESTS:

Field Permeability Tests were conducted in twenty two (22 nos.) borehole locations using falling head method as per IS: 5529 (Part 1) and single and double packer method as per IS: 5529 (Part 2). The test locations, type of test and depth of test are presented below.

Test Locations	Co-ordinates (M)		E.G.L. (M)	Type of Test	Depth of Test (M)
	Easting	Northing			
BH-01	1907	1573	366.373	Falling Head	1.00 – 1.60
				Falling Head	3.00 – 3.70
				Falling Head	5.00 – 5.65
				Double Packer	7.25 – 8.75
				Double Packer	9.25 – 10.75
BH-07	1827	1369	367.589	Falling Head	1.00 – 1.60
				Falling Head	2.40 - 3.00
				Single Packer	4.50 – 6.00
				Single Packer	7.50 – 9.00
				Single Packer	9.00 – 10.50
BH-11	1643	1253	374.215	Falling Head	1.00 – 1.60
				Falling Head	3.00 – 3.60
				Single Packer	4.50 – 6.00
				Single Packer	7.50 – 9.00
				Single Packer	9.00 – 10.50
BH-17	1643	1578	373.672	Falling Head	1.00 – 1.70
				Falling Head	2.80 – 3.40
				Double Packer	4.25 – 5.75
				Double Packer	7.25 – 8.75
				Double Packer	9.25 – 10.75
BH-24	1526	1429	377.587	Falling Head	1.00 – 1.60
				Falling Head	2.70 – 3.25
				Double Packer	4.25 – 5.75
				Double Packer	7.25 – 8.75
				Double Packer	9.25 – 10.75
BH-37	1426	1372	381.086	Falling Head	1.00 – 1.60

Test Locations	Co-ordinates (M)		E.G.L. (M)	Type of Test	Depth of Test (M)
	Easting	Northing			
BH-37	1426	1372	381.086	Falling Head	2.70 – 3.30
				Single Packer	4.75 – 6.25
				Single Packer	7.00 – 8.50
				Single Packer	9.25 – 10.75
BH-48	1469	1585	379.048	Falling Head	1.00 – 1.60
				Falling Head	2.90 – 3.50
				Single Packer	4.25 – 5.75
				Single Packer	7.25 – 8.75
				Single Packer	9.50 – 11.00
BH-67	1342	1478	382.209	Falling Head	1.00 – 1.60
				Single Packer	3.00 – 4.50
				Single Packer	4.50 – 6.00
				Single Packer	7.50 – 9.00
				Single Packer	9.00 – 10.50
BH-72	1342	1336	381.082	Falling Head	1.00 – 1.60
				Single Packer	3.00 – 4.50
				Single Packer	4.50 – 6.00
				Single Packer	7.50 – 9.00
				Single Packer	9.00 – 10.50
BH-77	1222	1301	373.467	Falling Head	0.90 – 1.50
				Single Packer	2.25 – 3.75
				Single Packer	4.50 – 6.00
				Single Packer	7.50 – 9.00
				Single Packer	9.00 – 10.50
BH-84	1222	1585	383.515	Falling Head	1.00 – 1.60
				Falling Head	3.00 – 3.60
				Double Packer	4.50 – 6.00
				Single Packer	7.25 – 8.75
				Single Packer	9.50 – 11.00
BH-89	1168	1660	383.036	Falling Head	1.00 – 1.60
				Single Packer	3.00 – 4.50
				Single Packer	4.50 – 6.00
				Single Packer	7.50 – 9.00
				Single Packer	9.00 – 10.50
BH-91	1059	1628	380.238	Falling Head	1.00 – 1.60
				Falling Head	3.00 – 3.60
				Single Packer	4.25 – 5.75
				Single Packer	7.25 – 8.75
				Single Packer	9.50 – 11.00
BH-101	1059	1471	376.090	Falling Head	1.00 – 1.60
				Falling Head	2.80 – 3.50
				Single Packer	4.00 – 5.50
				Single Packer	7.00 – 8.50
				Single Packer	9.00 – 10.50
BH-104	1138	1439	376.470	Falling Head	1.00 – 1.70
				Falling Head	2.60 – 3.20
				Single Packer	4.00 – 5.50
				Single Packer	7.00 – 8.50
				Single Packer	9.25 – 10.75
BH-112	1059	1325	372.518	Falling Head	1.00 – 1.60
				Single Packer	2.50 – 4.00
				Single Packer	4.00 – 5.50
				Single Packer	7.00 – 8.50
				Single Packer	9.25 – 10.75

Test Locations	Co-ordinates (M)		E.G.L. (M)	Type of Test	Depth of Test (M)
	Easting	Northing			
BH-115	1109	1301	374.711	Falling Head	1.00 – 1.60
				Falling Head	3.00 – 3.60
				Single Packer	4.55 – 6.05
				Single Packer	7.55 – 9.05
				Single Packer	9.05 – 10.55
BH-123	819	1663	382.428	Falling Head	1.00 – 1.60
				Falling Head	3.00 – 3.50
				Single Packer	4.50 – 6.00
				Single Packer	7.50 – 9.00
				Single Packer	9.00 – 10.50
BH-128	822	1375	375.167	Falling Head	1.00 – 1.60
				Falling Head	2.80 – 3.20
				Single Packer	4.00 – 5.50
				Single Packer	7.00 – 8.50
				Single Packer	9.05 – 10.55
BH-140	639	1455	377.701	Falling Head	1.00 – 1.60
				Falling Head	2.90 – 3.50
				Single Packer	4.25 – 5.75
				Single Packer	7.25 – 8.75
				Single Packer	8.75 – 10.25
BH-152	406	1285	387.603	Falling Head	1.00 – 1.60
				Double Packer	2.60 – 4.10
				Single Packer	4.75 – 6.25
				Single Packer	7.00 – 8.50
				Single Packer	9.25 – 10.75
BH-161	1425	1151	374.139	Falling Head	1.00 – 1.60
				Falling Head	3.00 – 3.60
				Double Packer	4.25 – 5.75
				Single Packer	6.75 – 8.25
				Single Packer	8.50 – 10.00

2.11. ELECTRICAL RESISTIVITY TESTS:

Fifty eight (58) nos. Electrical Resistivity Tests were carried out at the following locations. The test procedure and results are presented in Volume-2 (Part IB).

ERT	Co-ordinate (M)		E.G.L. (M)	ERT	Co-ordinate (M)		E.G.L. (M)
	Easting	Northing			Easting	Northing	
ERT-01	1867	1298	372.511	ERT-30	1262	1372	375.882
ERT-02	1787	1369	371.162	ERT-31	1182	1265	373.123
ERT-03	1907	1369	369.023	ERT-32	1059	1308	372.598
ERT-04	1827	1437	369.653	ERT-33	1116	1377	374.606
ERT-05	1787	1505	368.354	ERT-34	1059	1454	376.521
ERT-06	1907	1505	364.353	ERT-35	1113	1541	379.389
ERT-07	1867	1573	366.350	ERT-36	1059	1611	378.889
ERT-08	1593	1578	374.989	ERT-37	1082	1662	380.223
ERT-09	1593	1448	374.196	ERT-38	988	1570	376.322
ERT-10	1593	1318	375.511	ERT-39	968	1392	374.500
ERT-11	1541	1242	376.449	ERT-40	981	1296	377.000
ERT-12	1516	1293	377.509	ERT-41	848	1656	382.287
ERT-13	1543	1383	377.500	ERT-42	848	1510	379.823

ERT	Co-ordinate (M)		E.G.L. (M)	ERT	Co-ordinate (M)		E.G.L. (M)
	Easting	Northing			Easting	Northing	
ERT-14	1543	1513	376.838	ERT-43	815	1408	375.493
ERT-15	1543	1643	376.486	ERT-44	703	1445	378.107
ERT-16	1448	1620	379.339	ERT-45	640	1505	380.196
ERT-17	1448	1549	382.839	ERT-46	543	1438	379.769
ERT-18	1448	1495	380.127	ERT-47	644	1384	379.214
ERT-19	1448	1407	379.111	ERT-48	507	1298	385.085
ERT-20	1448	1289	378.711	ERT-49	311	1272	388.186
ERT-21	1413	1242	378.424	ERT-50	841	850	374.103
ERT-22	1382	1301	379.037	ERT-51	1849	1540	365.947
ERT-23	1302	1313	377.863	ERT-52	1867	1476	368.500
ERT-24	1302	1456	380.822	ERT-53	1867	1400	367.294
ERT-25	1382	1443	381.831	ERT-54	1827	1333	370.813
ERT-26	1302	1637	382.010	ERT-55	1502	1560	377.632
ERT-27	1382	1656	381.103	ERT-56	1502	1461	378.152
ERT-28	1222	1656	384.225	ERT-57	1502	1351	371.779
ERT-29	1222	1514	381.669	ERT-58	800	1643	382.500

2.12. PRESSURE METER TESTS:

Total nine sets of Pressure Meter Test were conducted at the following locations. The test procedure and results are presented in Volume-2 (Part IB).

PMT No.	Co-ordinates (M)		E.G.L. (M)	PMT No.	Co-ordinates (M)		E.G.L. (M)
	Easting	Northing			E	N	
PMT-01	1448	1656	379.567	PMT-06	1342	1656	381.909
PMT-02	1448	1514	380.363	PMT-07	1168	1596	382.497
PMT-03	1448	1372	382.258	PMT-08	1138	1503	378.643
PMT-04	1342	1372	379.473	PMT-09	1169	1293	374.787
PMT-05	1342	1514	381.575				

2.13. CROSS HOLE SHEAR TESTS:

Twelve nos. of Crosshole Shear Test were carried out to determine the dynamic properties of the layer at the following locations. The test procedure and results are presented and discussed in Volume-2 (Part IB).

CST No.	Co-ordinates (M)		E.G.L. (M)	CST No.	Co-ordinates (M)		E.G.L. (M)
	Easting	Northing			E	N	
CST-01	1454	1616	379.132	CST-07	1102	1620	379.838
CST-02	1454	1460	379.823	CST-08	1102	1478	376.359
CST-03	1454	1314	379.468	CST-09	1102	1336	373.212
CST-04	1302	1336	378.432	CST-10	1159	1325	376.446
CST-05	1342	1407	380.876	CST-11	1159	1478	378.784
CST-06	1302	1549	382.876	CST-12	1159	1628	382.688

3. LABORATORY TESTING

For proper identification and classification of the sub-soil deposits and for deriving adequate information regarding its relevant physical and geotechnical properties at the site under investigation, the following laboratory tests were conducted on the soil / rock samples collected from the exploratory bore holes:

On Soil Samples:

1. **Grain size analysis (Sieve as well as Hydrometer).**
2. **Determination of Liquid Limit, Plastic Limit and Shrinkage Limit.**
3. **Determination of Natural Moisture Content.**
4. **Determination of Specific Gravity.**
5. **Determination of Bulk & Dry Unit Weight.**
6. **Strength determination by Triaxial Unconsolidated Undrained Test (UU).**
7. **Strength Determination of Unconfined Compression Test on "UDS" (UNCONFD).**
8. **Strength Determination of Unconfined Compression Test on REMOULDED samples.**
9. **Strength determination by Direct Shear Test.**
10. **One-dimensional Consolidation Test for determining settlement potentiality.**
11. **Determination of Free Swelling Index & Swelling Pressure.**
12. **Conducting Standard Proctor Compaction Test to determine Optimum Moisture Content (OMC) and Maximum Dry Density (MDD).**
13. **Conducting CBR test (unsoaked & soaked) on sample prepared at 95% of MDD.**
14. **Chemical tests on soil and water samples to determine pH value, Sulphate, Chloride content etc.**

On Rock Samples:

1. **Determination of Bulk Density, Water Content, Specific Gravity & Porosity of Rock.**
2. **Determination of Unconfined Compressive Strength of Rock samples (Saturated & In-situ State)**
3. **Determination of Point Load Strength Index.**
4. **Determination of Slake Durability Index of Rock.**
5. **Determination of Hardness, Soundness and Deformability both at saturated and in-situ water content.**

Laboratory test results are presented in a tabular form in Volume - 2. The results are self explanatory excepting that of consolidation tests. The compressibility for a pressure range has been separated into 2 components through the compression ratio. As a first step dial gauge reading is plotted against square root of time and by extrapolation dial reading at zero time, is obtained. The compression ratio is given as

$r = (d_i - d_s)/(d_i - d_f)$, where

d_i = Initial reading of dial before load application

d_s = Dial reading corresponding to theoretical zero time

d_f = Final dial reading after 24 hrs.

Now we write $m_{vc} = (1- r) \times m_v$

All the tests were conducted as per relevant Indian Standard Specifications.

4. SUBSOIL CONDITION, STRATIFICATION AND PROPERTIES

4.1. SUB-SOIL CONDITION:

The boring records showing the various soils met with are enclosed in Volume-2. These are prepared from field logs after proper modifications in the light of the laboratory test results and observation of disturbed and penetrometer soil samples. The results of the Standard Penetration Tests are given as 'N' values in these boring records. The sub-soil profiles (as obtained from field and Laboratory test results) across the bore holes are shown under Figs. 2.01 to 2.51 giving description, consistency and colour of each strata. The "N" values are shown in the profiles as well as presented in the borelogs. The laboratory test results and the back up sheets are also presented there.

4.2. SUB-SOIL STRATIFICATION:

The subsoil is characterised by silty clay / silty sand layer with varying consistency. After the soil layer, rock layer is struck and that continues upto the terminating depth of all the boreholes. The description of each layer is presented below.

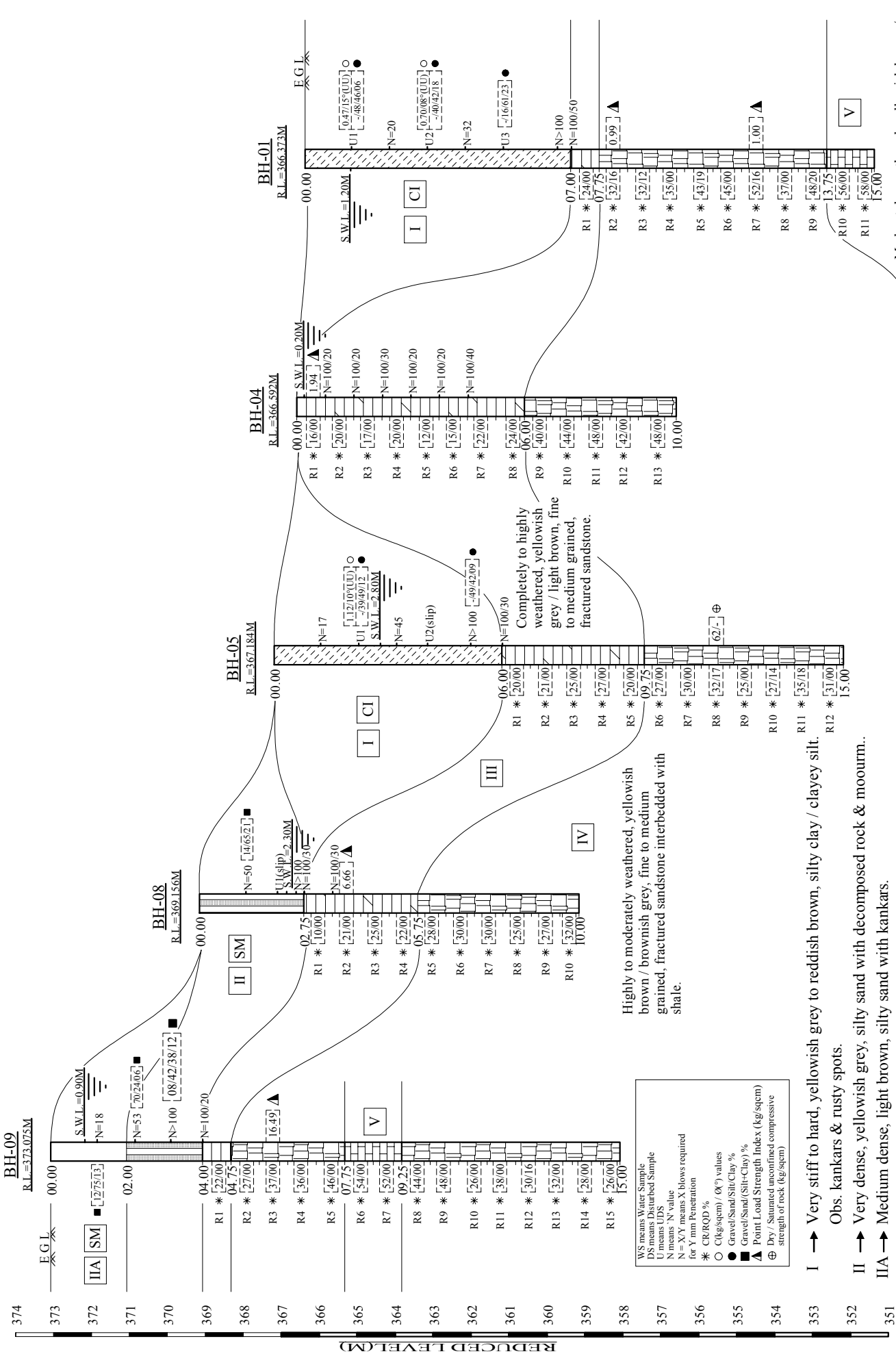
4.2.1. Fill:

The filled up soil consists of deep / light grey, fly ash. Deep / brownish grey, silty clay with ash, kankar, gravel etc. also have been observed at places.

4.2.2. STRATUM - I:

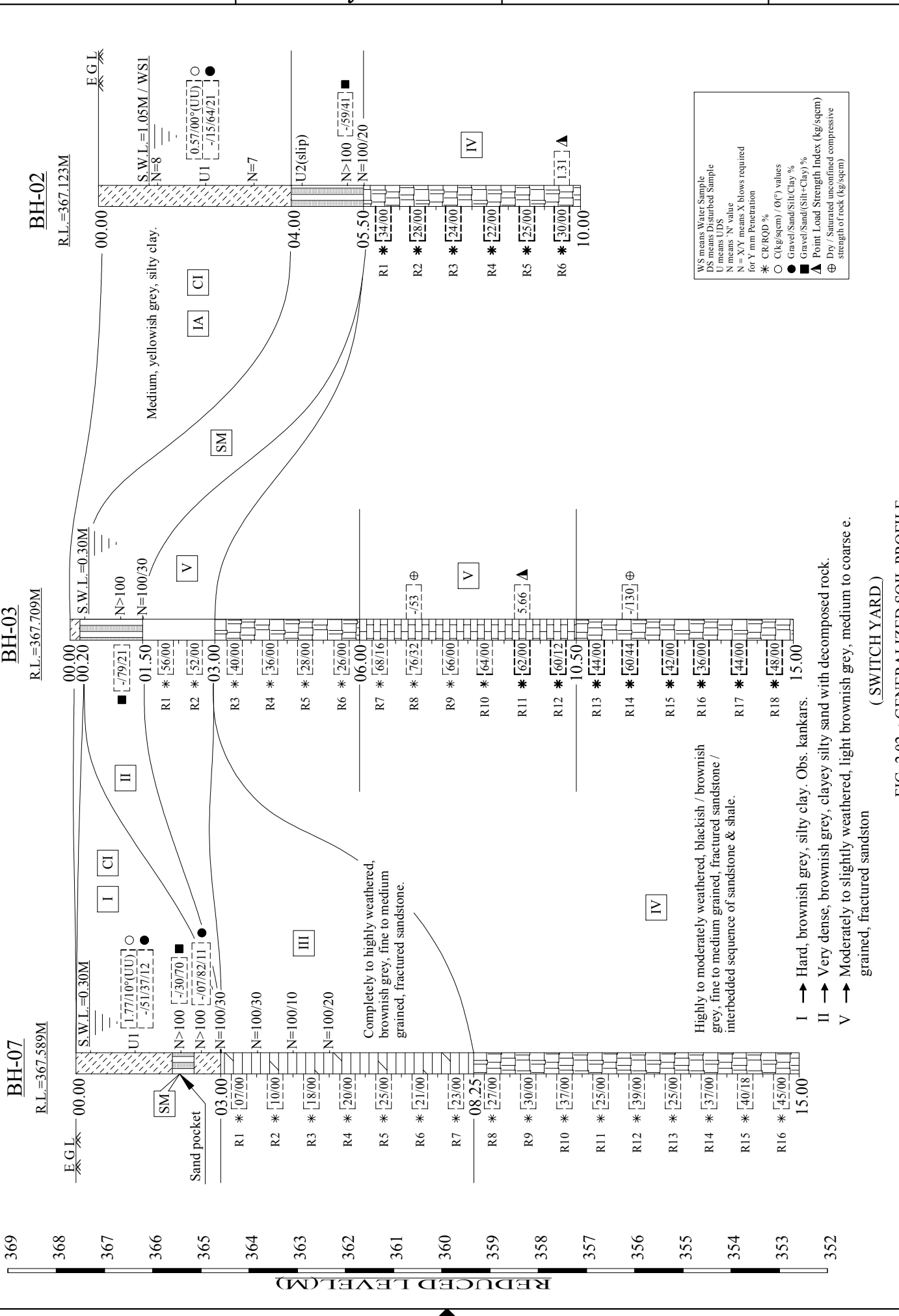
The soil in this layer consists of very stiff to hard, brownish / yellowish grey to reddish / yellowish brown, silty clay / clayey silt with sand mixture. Decomposed rock fragments, moorum & kankar have been observed in this layer. Routine laboratory tests conducted on the "UDS", few “DS” and “SPT” samples that could be collected from this layer show the following average properties.

Bulk Density, gms/cc	2.06	Specific gravity	2.65
Dry Density, gms/cc	1.78	Void Ratio	0.520
Natural Water Content %	16	Liquid limit %	39
TRSH-UU:		Plastic Limit %	19
Cohesion kg/sqcm	1.05	Shrinkage Limit %	14
Friction angle °	9°	**GRAIN SIZE**	
		Gravel %	01
Unconfined cohesion, kg/sqcm	**1.20**	Sand %	34
Remoulded cohesion, kg/sqcm	**0.91**	Silt %	47
SENSITIVITY, S_t	**1.32**	Clay %	18



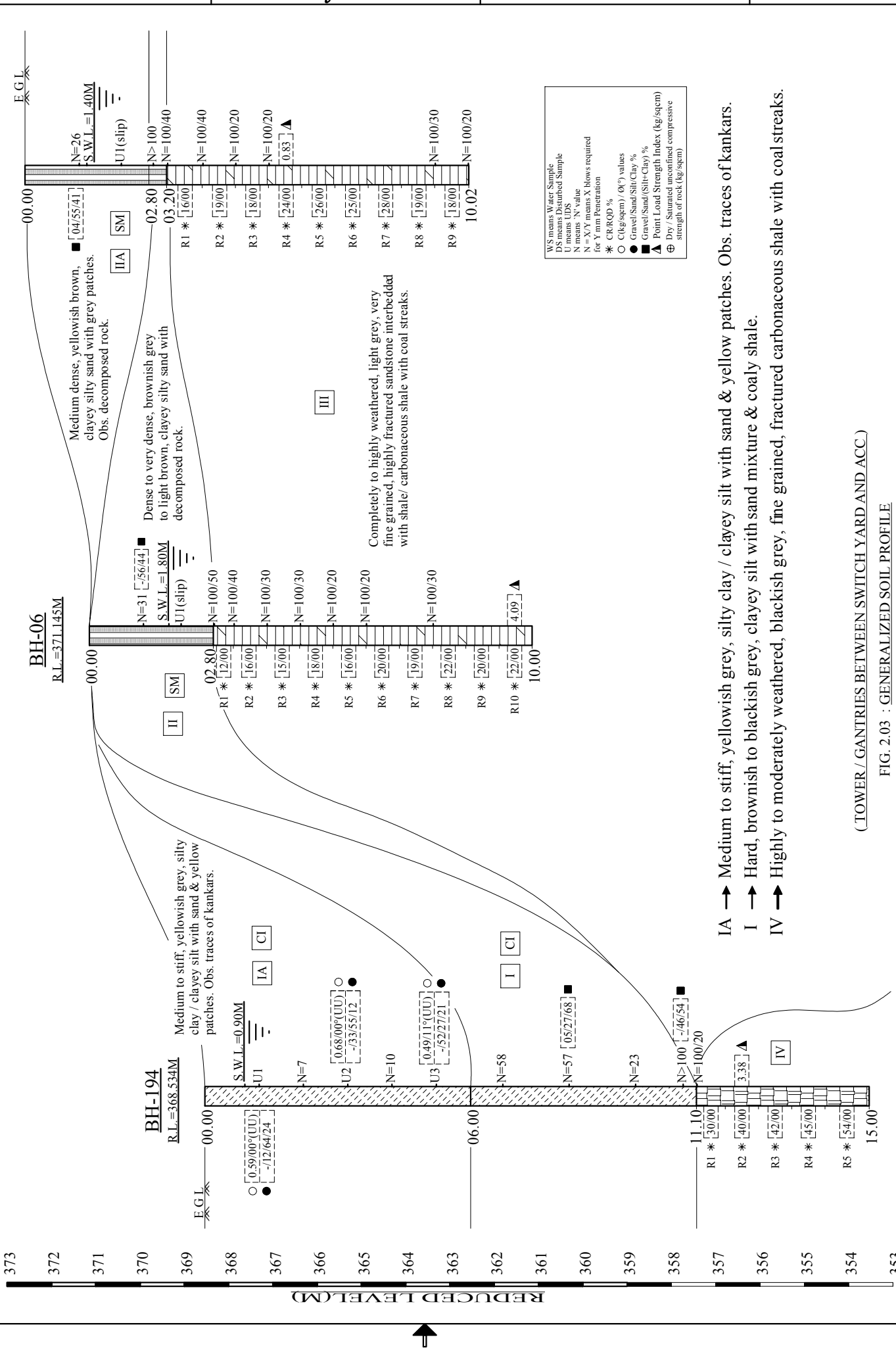
(SWITCH YARD)

FIG. 2.01 : GENERALIZED SOIL PROFILE



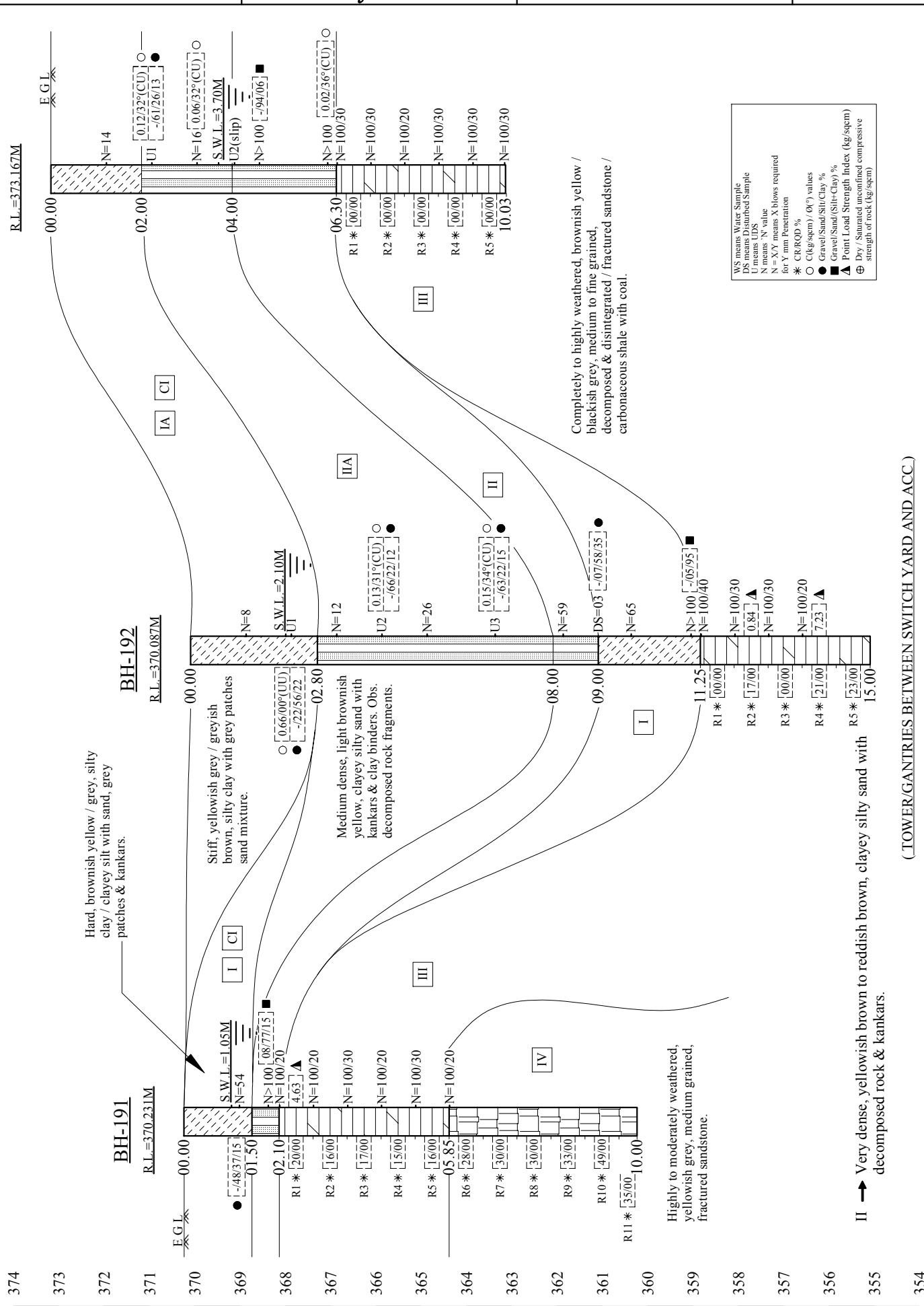
(SWITCH YARD)

FIG. 2.02 : GENERALIZED SOIL PROFILE



(TOWER / GANTRIES BETWEEN SWITCH YARD AND ACC)

FIG. 2.03 : GENERALIZED SOIL PROFILE



(TOWER/GANTRIES BETWEEN SWITCH YARD AND ACC.)

FIG. 2.04 : GENERALIZED SOIL PROFILE

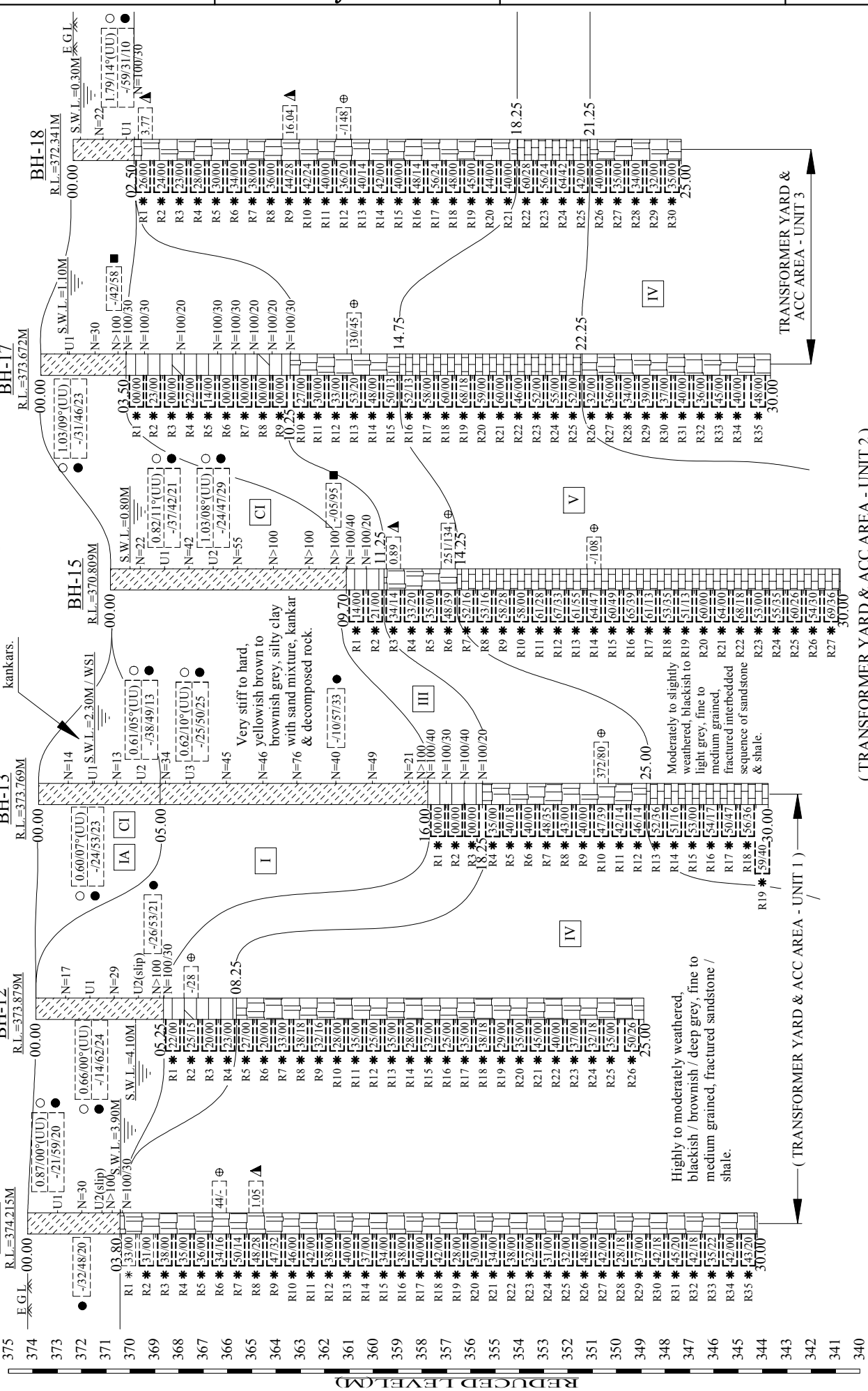


FIG. 2.05 : GENERALIZED SOIL PROFILE

III → Completely to highly weathered, blackish grey, fine to medium grained, highly fractured, interbedded sequence of sand stone & shale.

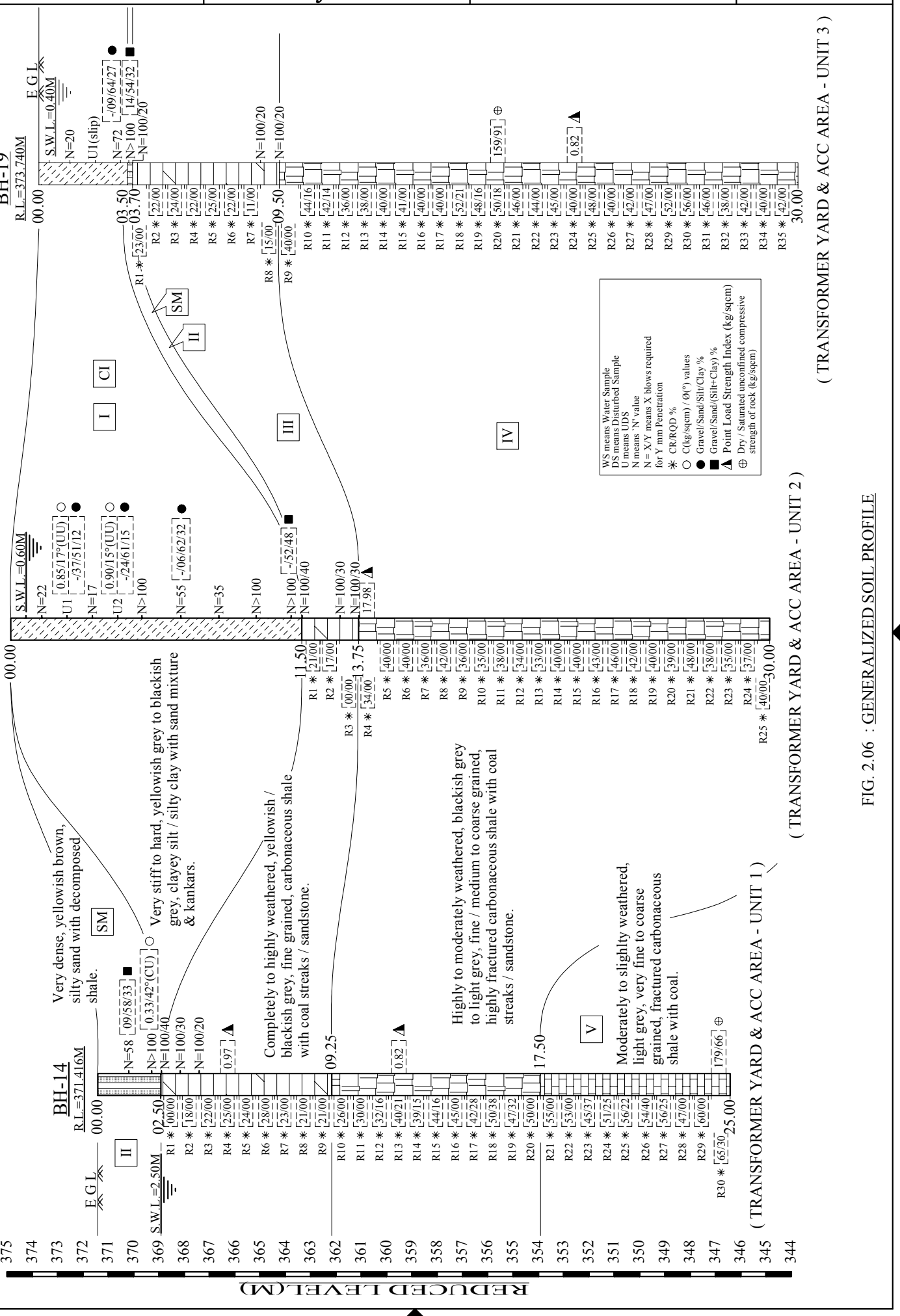


FIG. 2.06 : GENERALIZED SOIL PROFILE

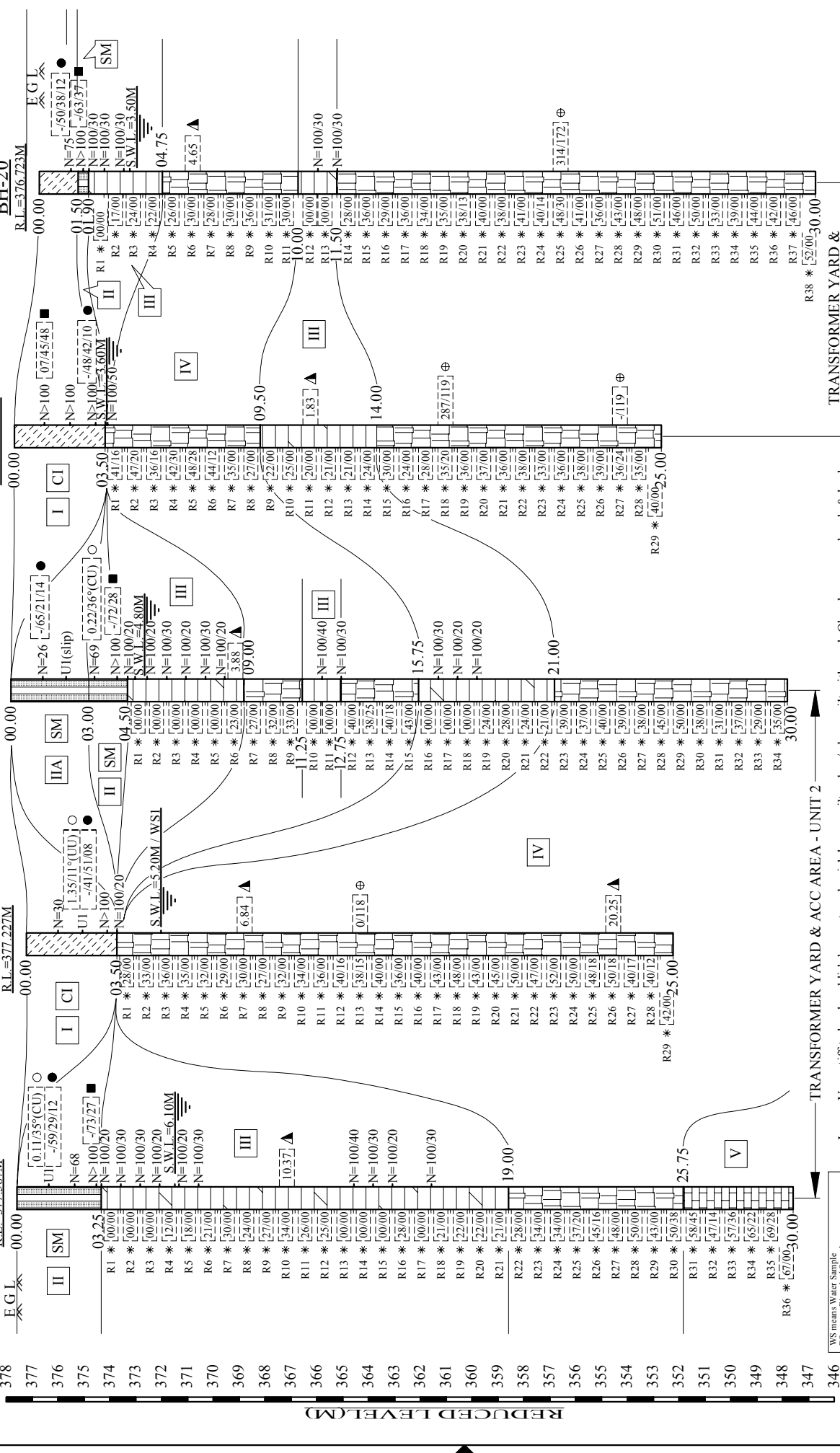


FIG. 2.07 : GENERALIZED SOIL PROFILE

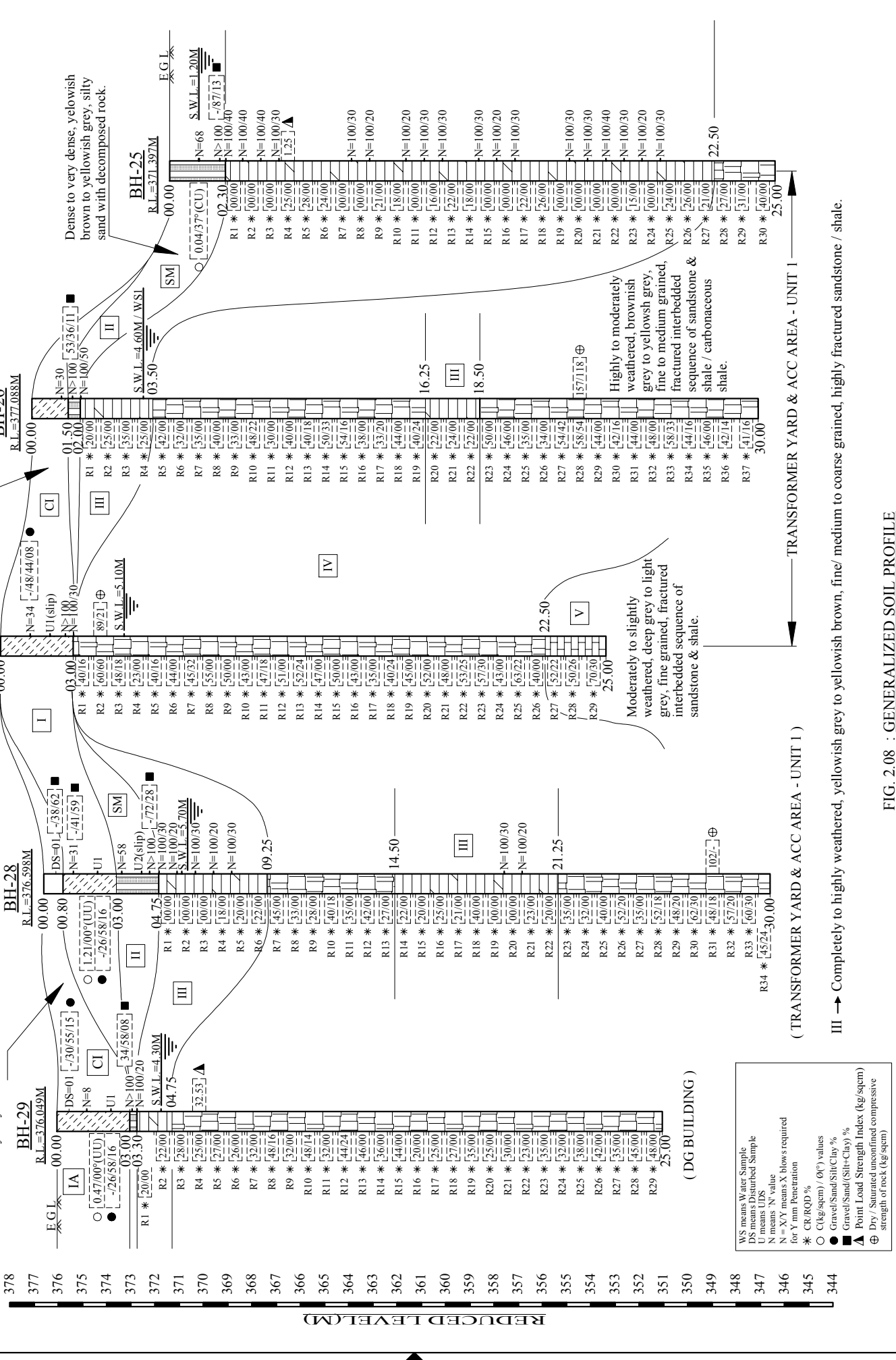


FIG. 2.08 : GENERALIZED SOIL PROFILE

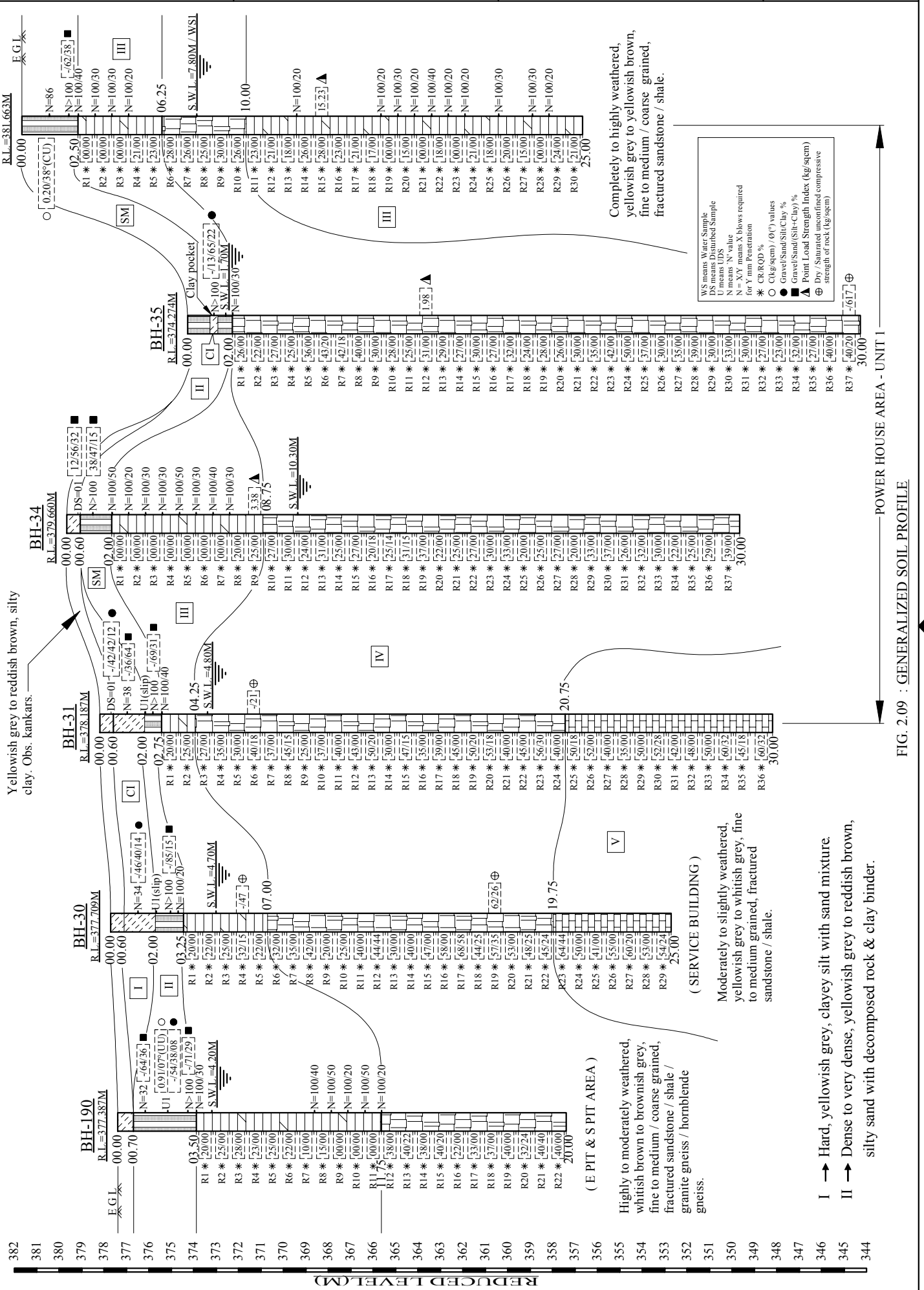
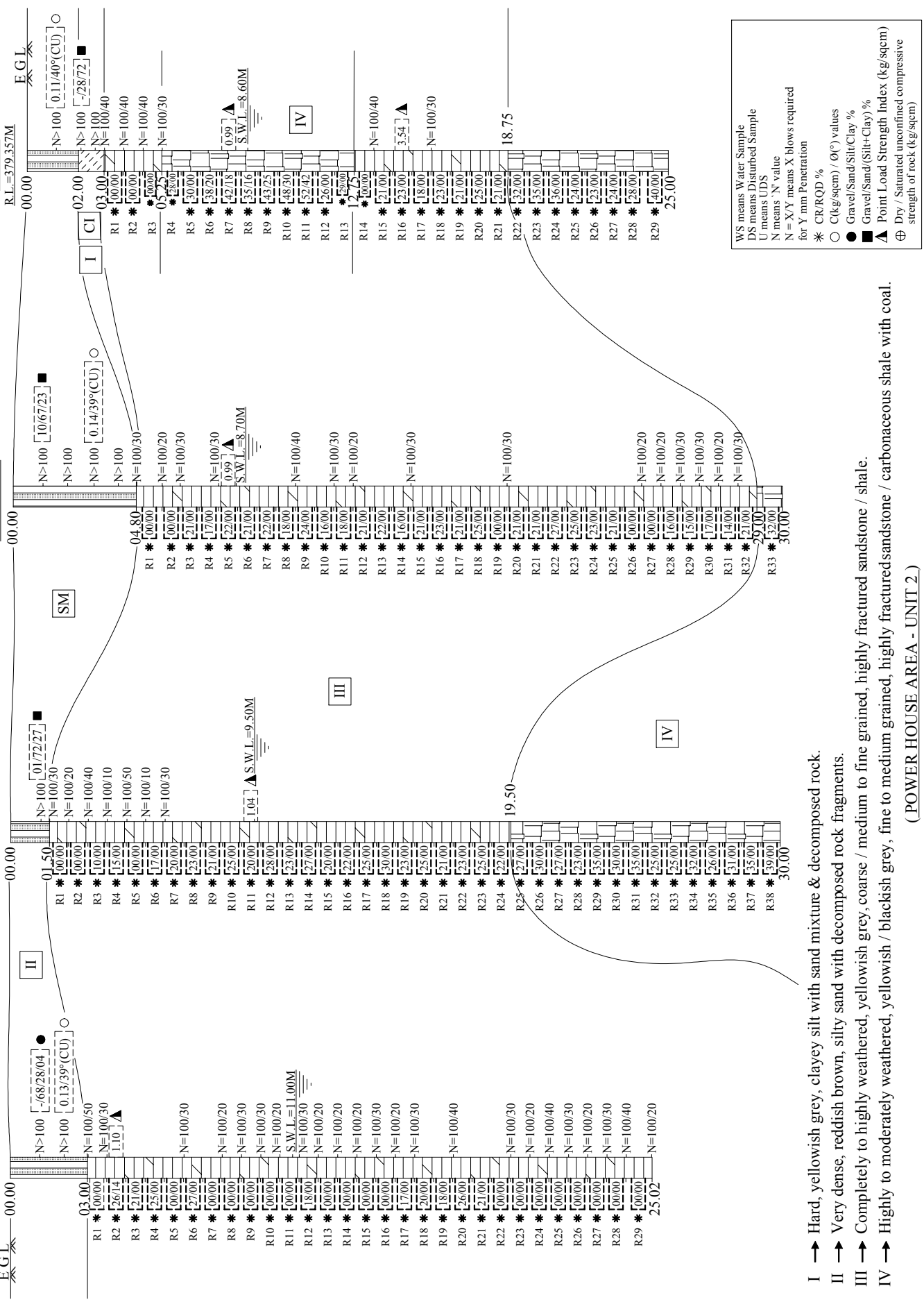
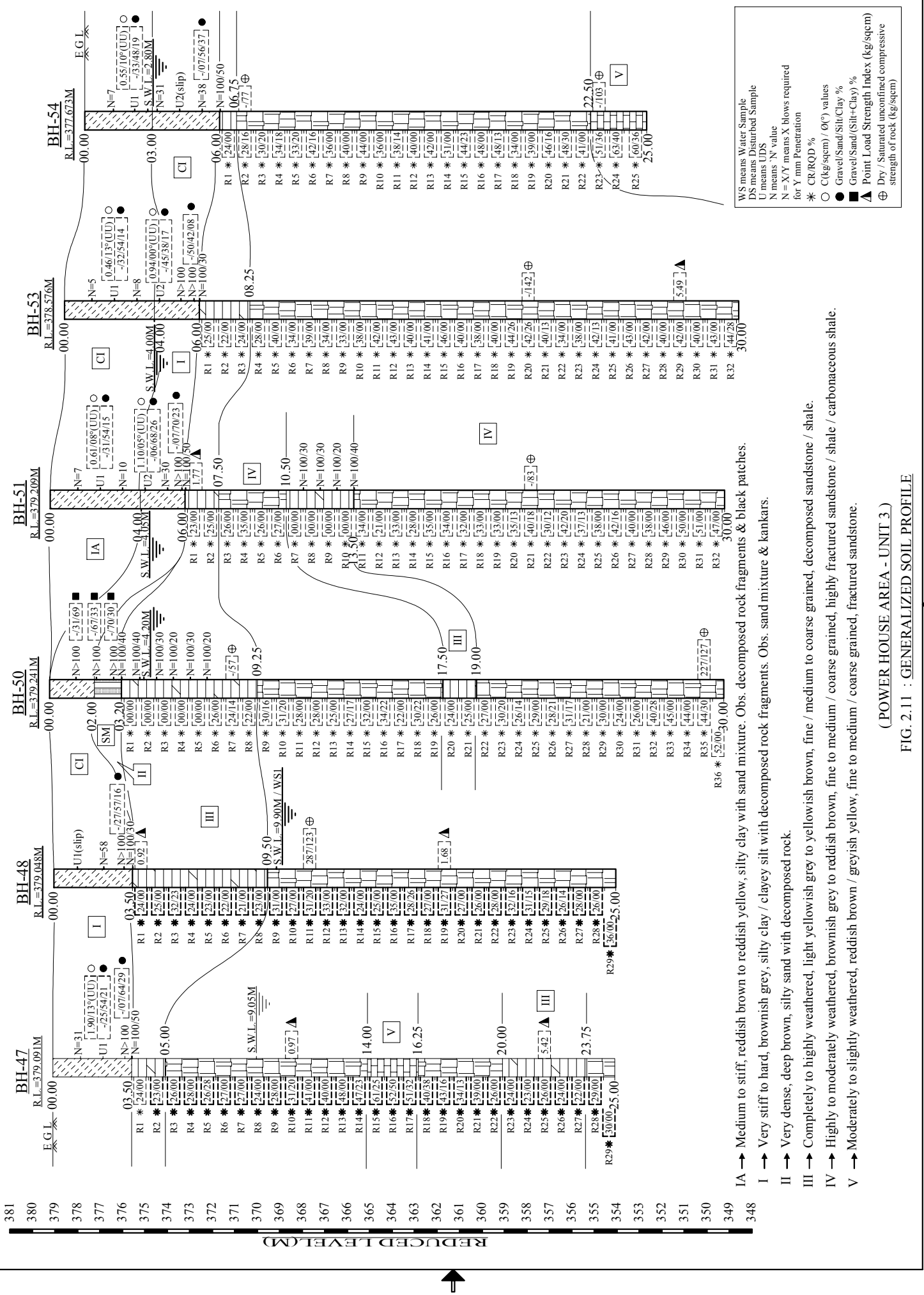


FIG. 2.09 : GENERALIZED SOIL PROFILE



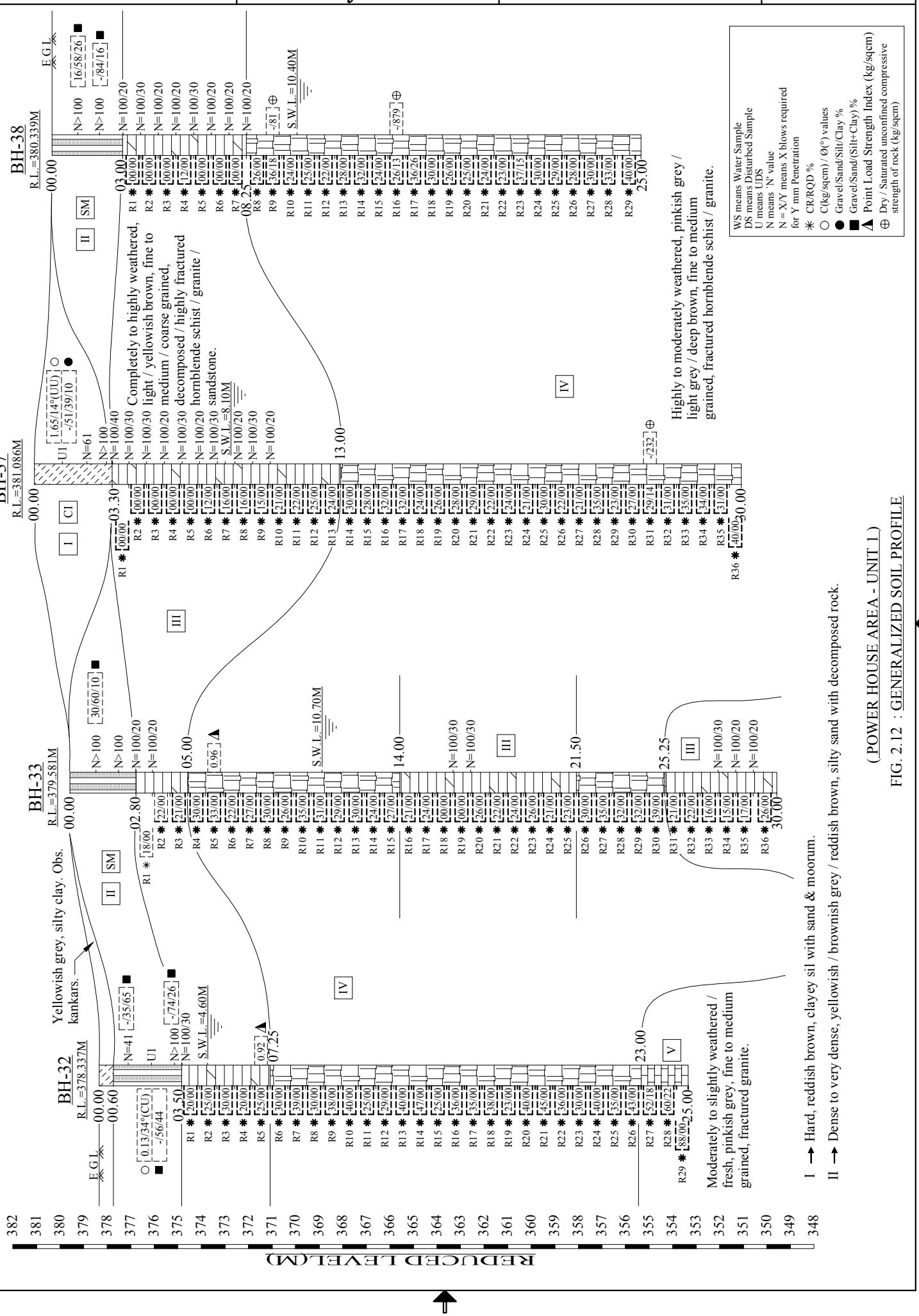
(POWER HOUSE AREA - UNIT 2)

FIG. 2.10 : GENERALIZED SOIL PROFILE



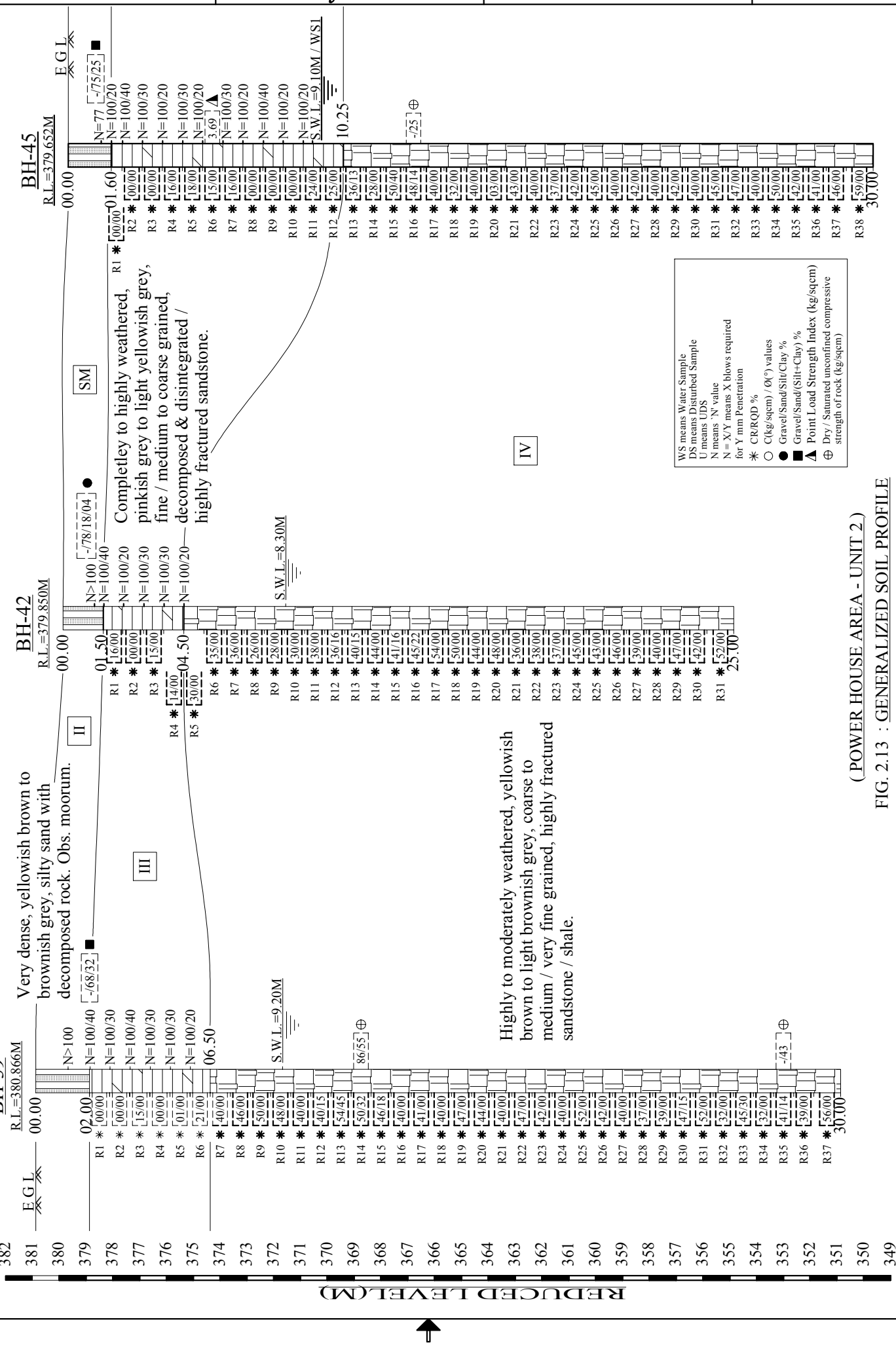
(POWER HOUSE AREA - UNIT 3)

FIG. 2.11 : GENERALIZED SOIL PROFILE



(POWER HOUSE AREA - UNIT 1)

FIG. 2.12 : GENERALIZED SOIL PROFILE



(POWER HOUSE AREA - UNIT 2)

FIG. 2.13 : GENERALIZED SOIL PROFILE

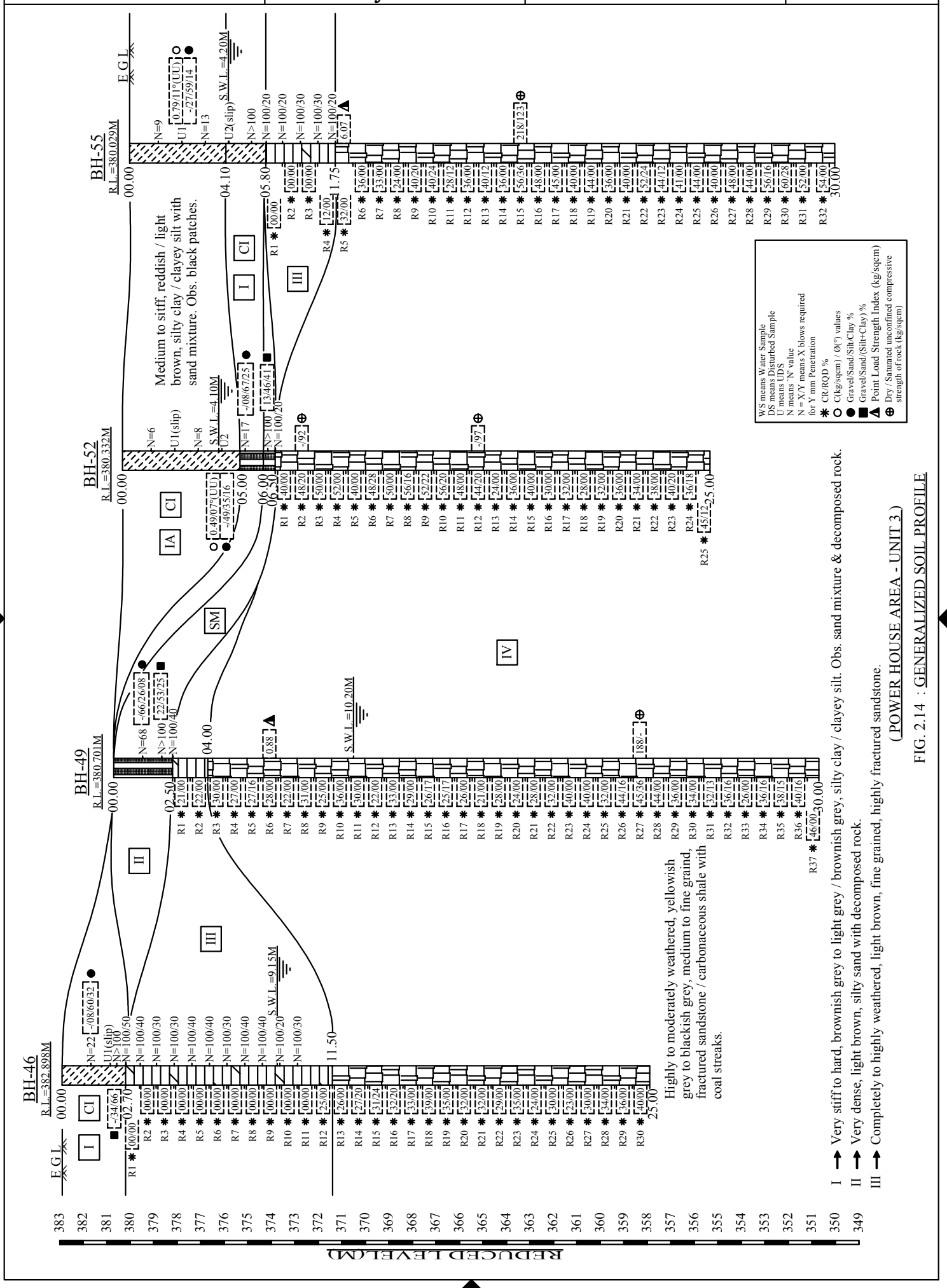
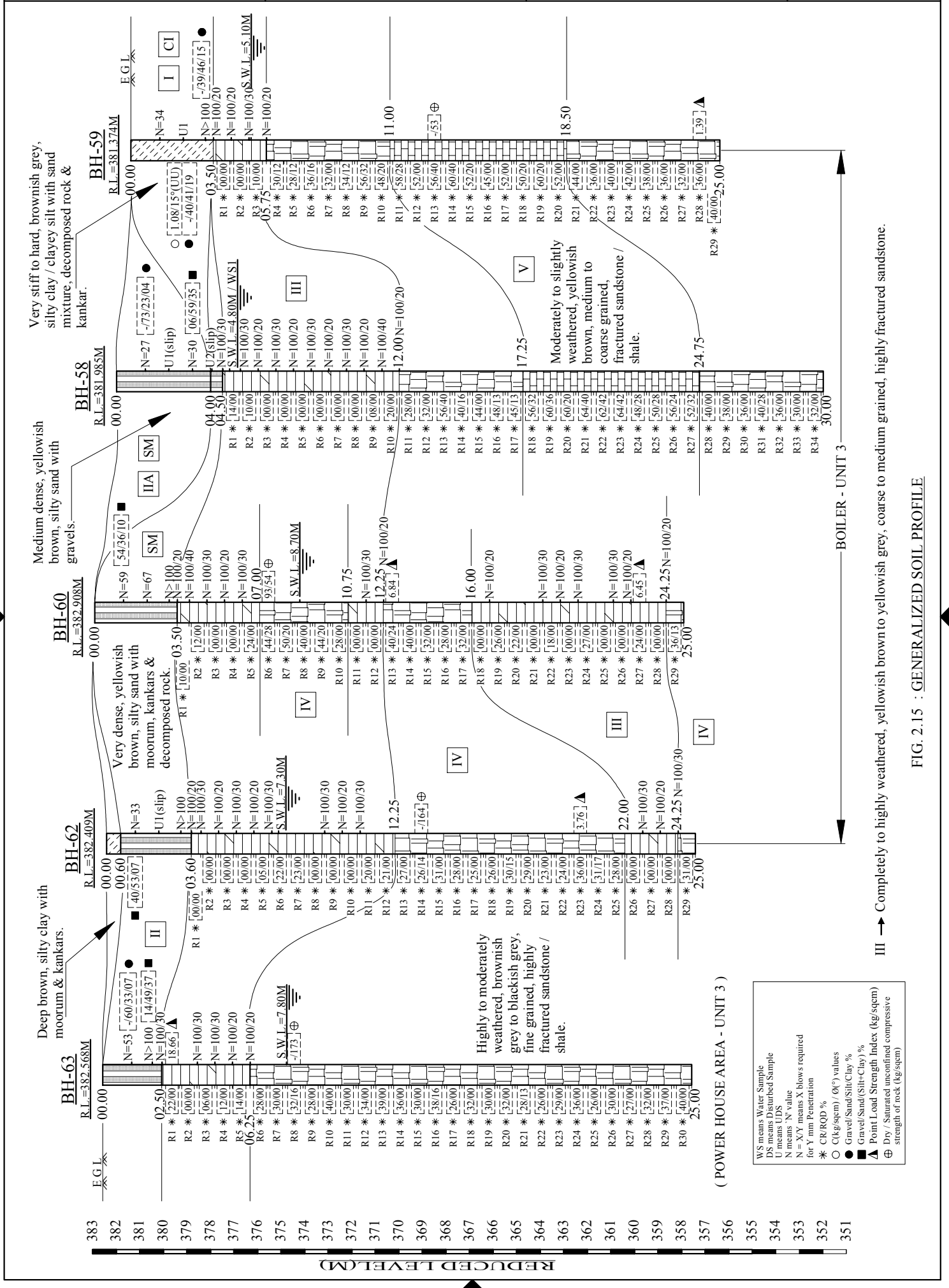
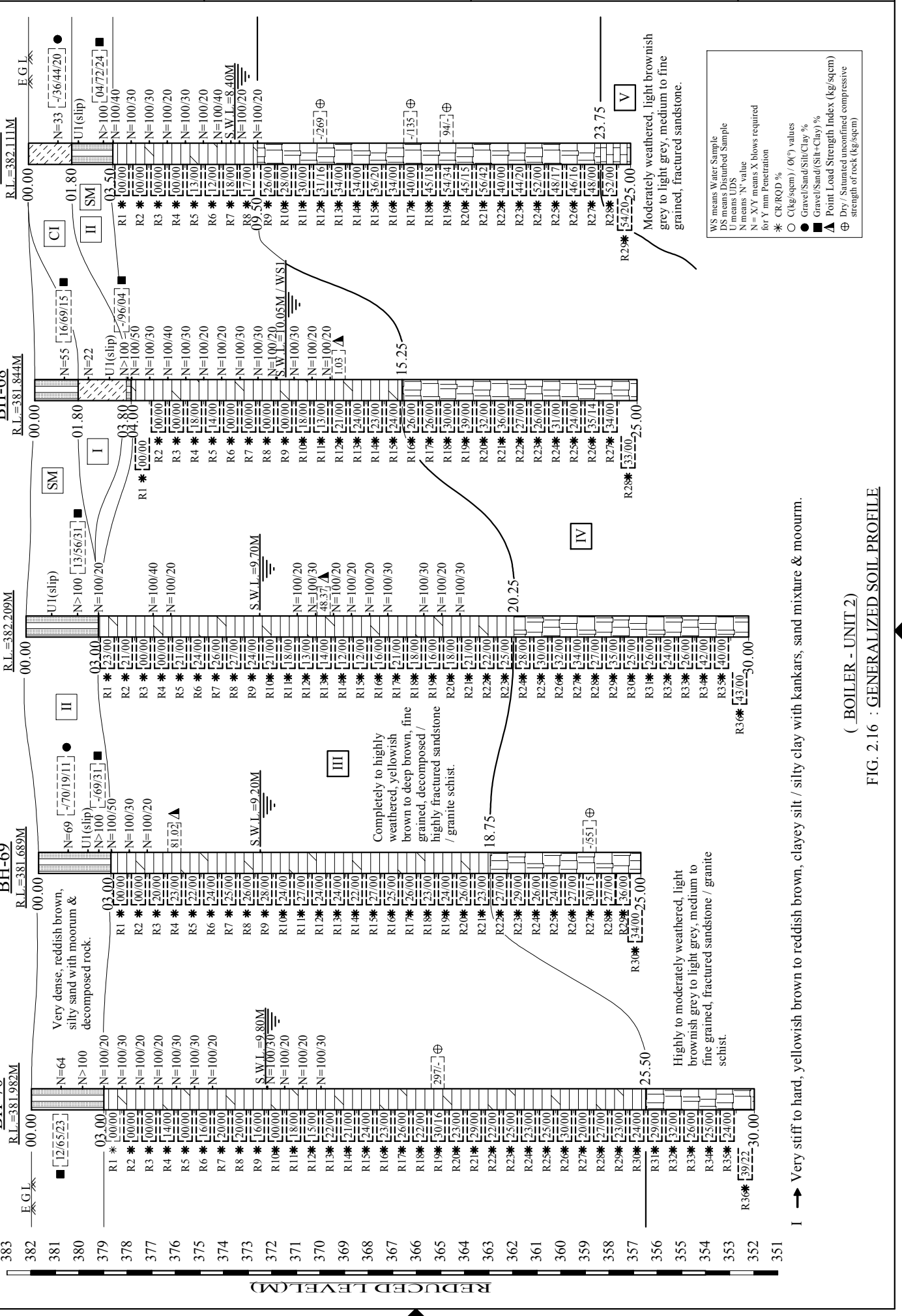


FIG. 2.14 : GENERALIZED SOIL PROFILE
(POWER HOUSE AREA - UNIT 3)



III → Completely to highly weathered, yellowish brown to yellowish grey, coarse to medium grained, highly fractured sandstone.

FIG. 2.15 : GENERALIZED SOIL PROFILE



(BOILER - UNIT 2)

FIG. 2.16 : GENERALIZED SOIL PROFILE

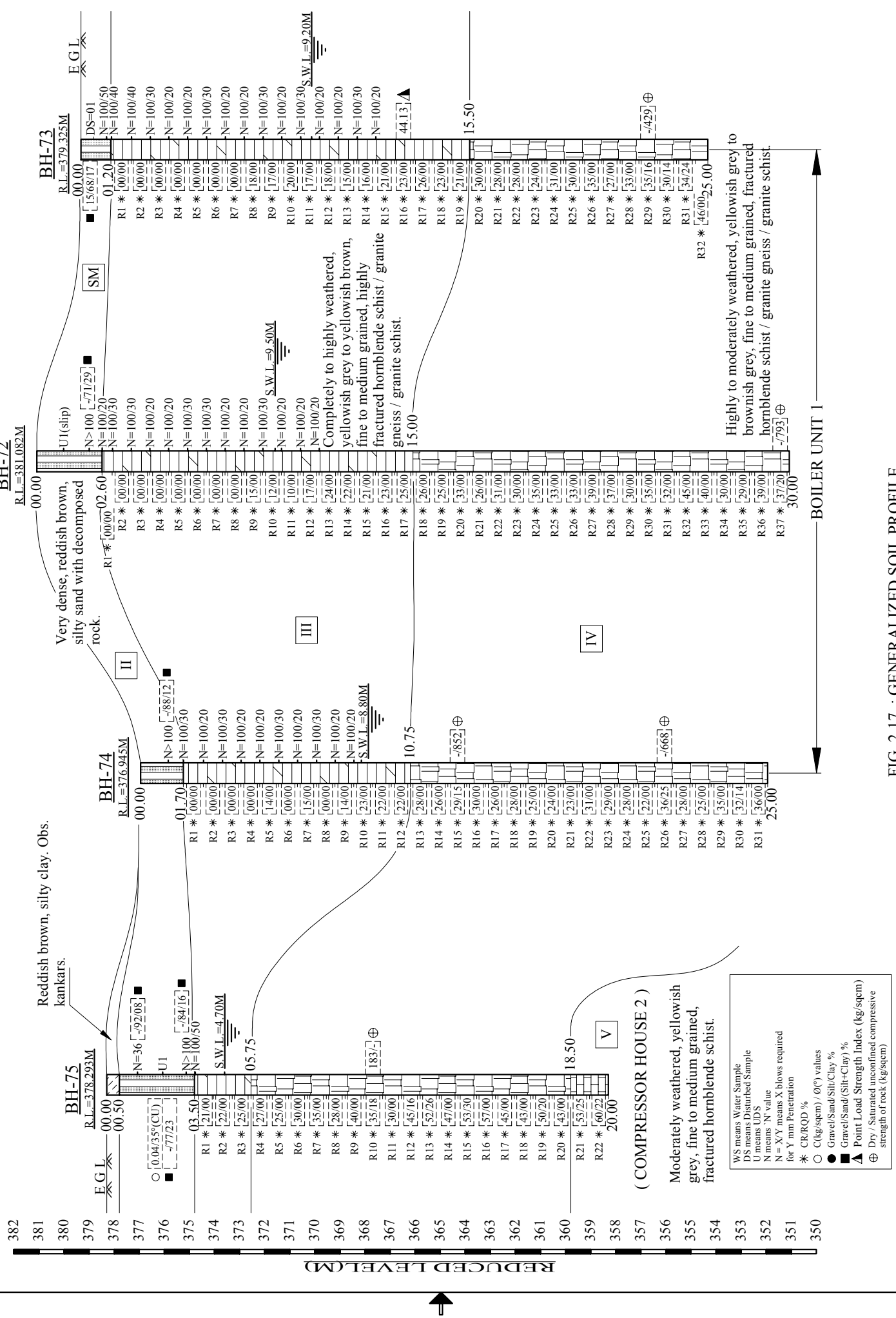


FIG. 2.17 : GENERALIZED SOIL PROFILE

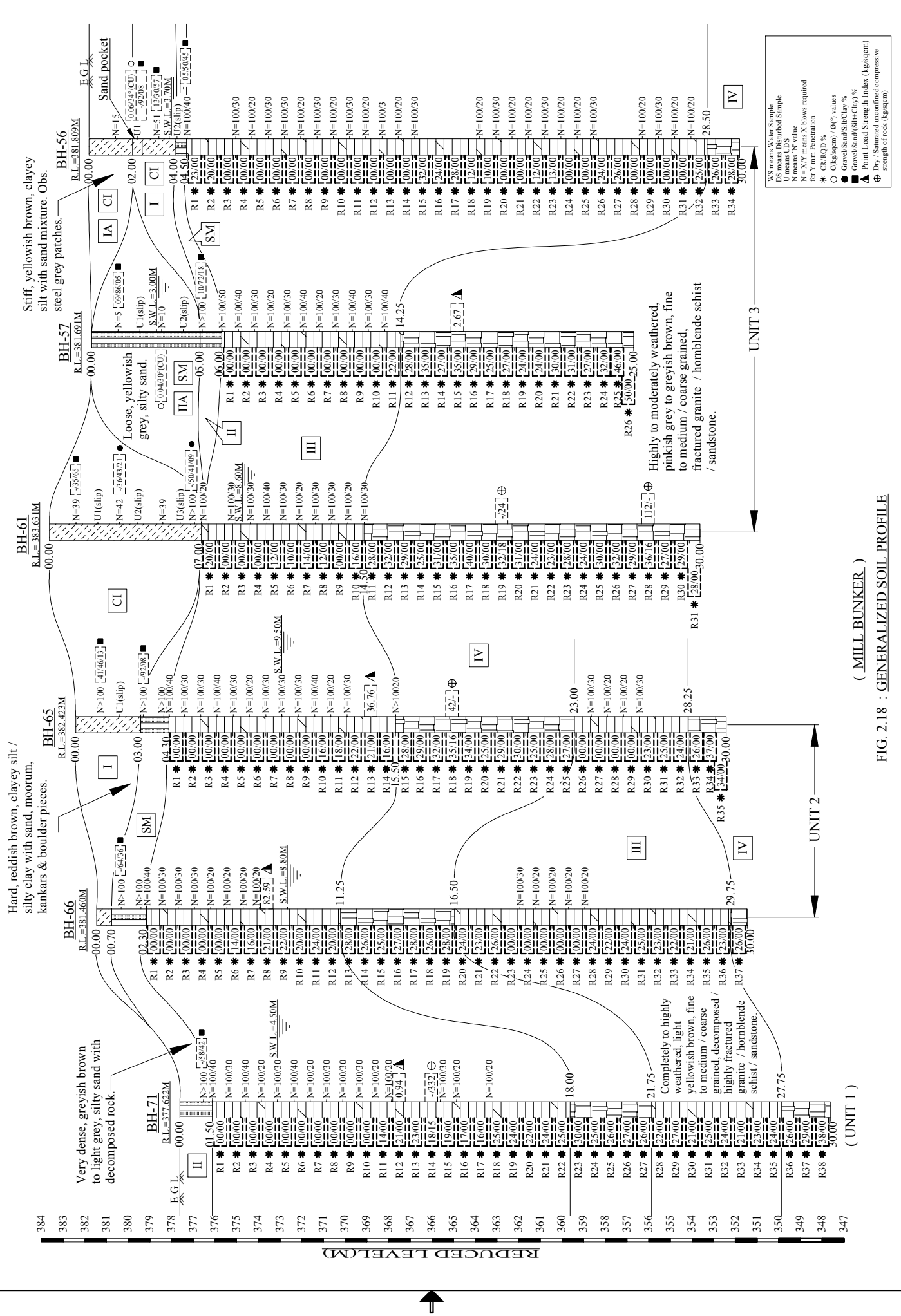
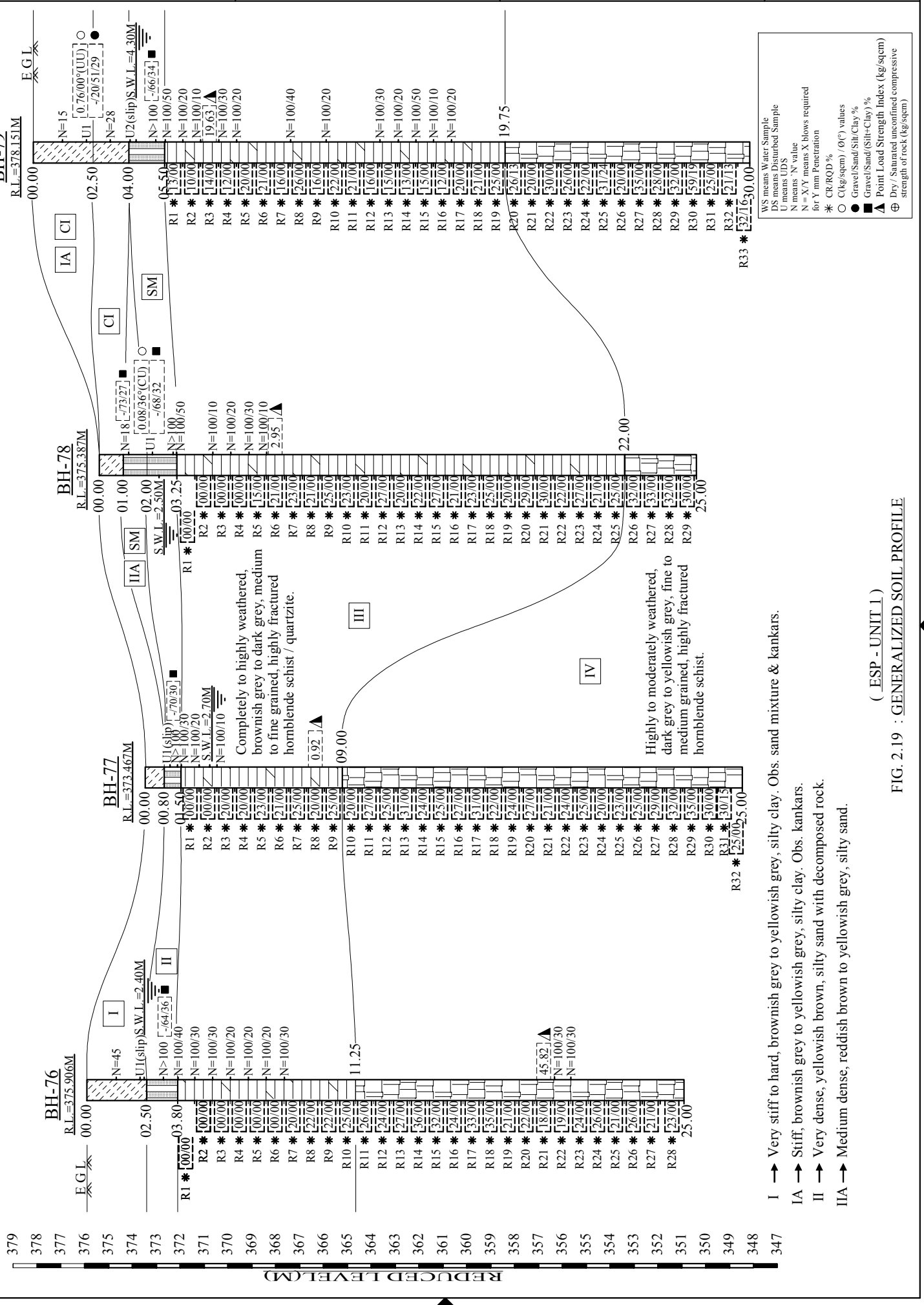
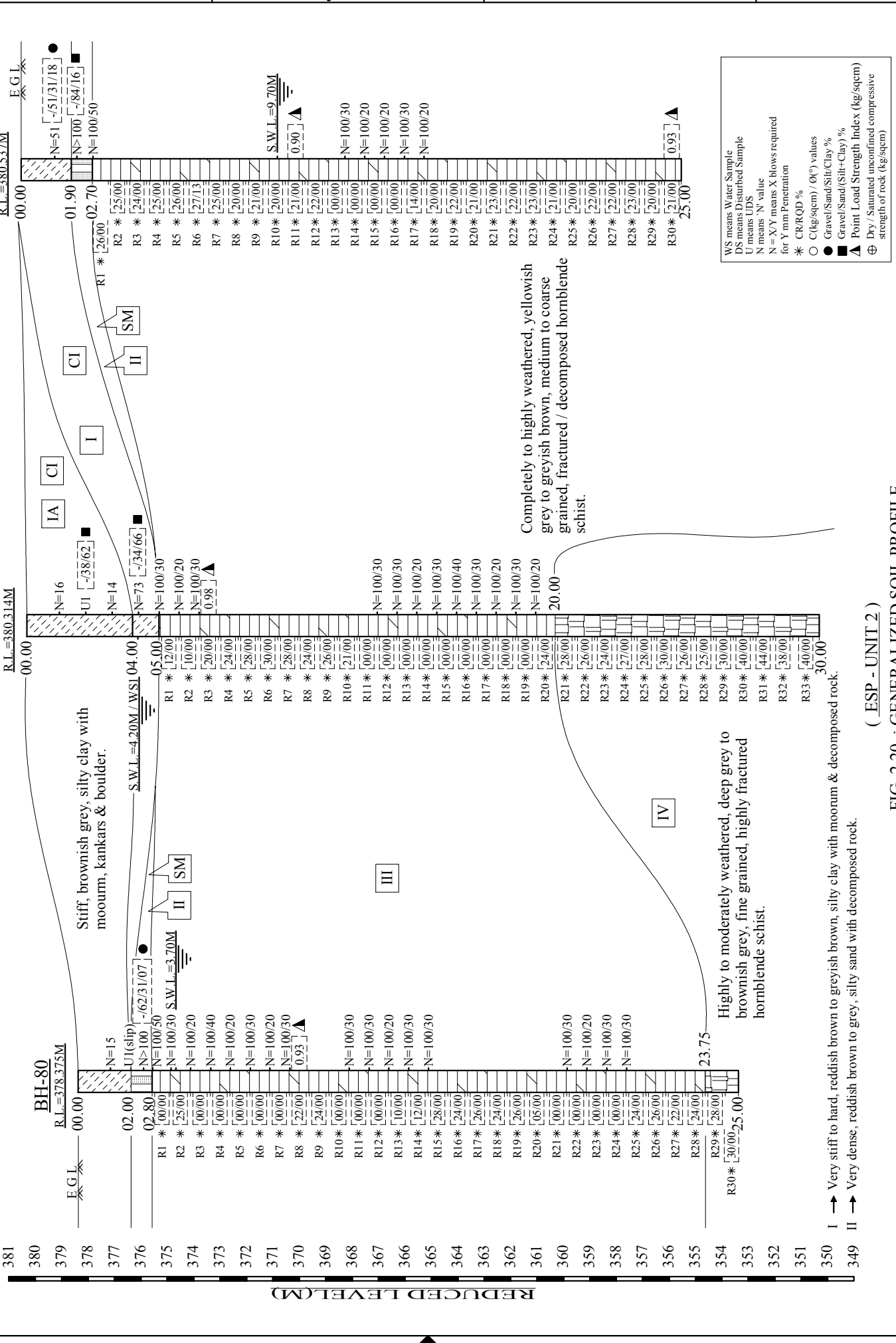


FIG. 2.18 : GENERALIZED SOIL PROFILE



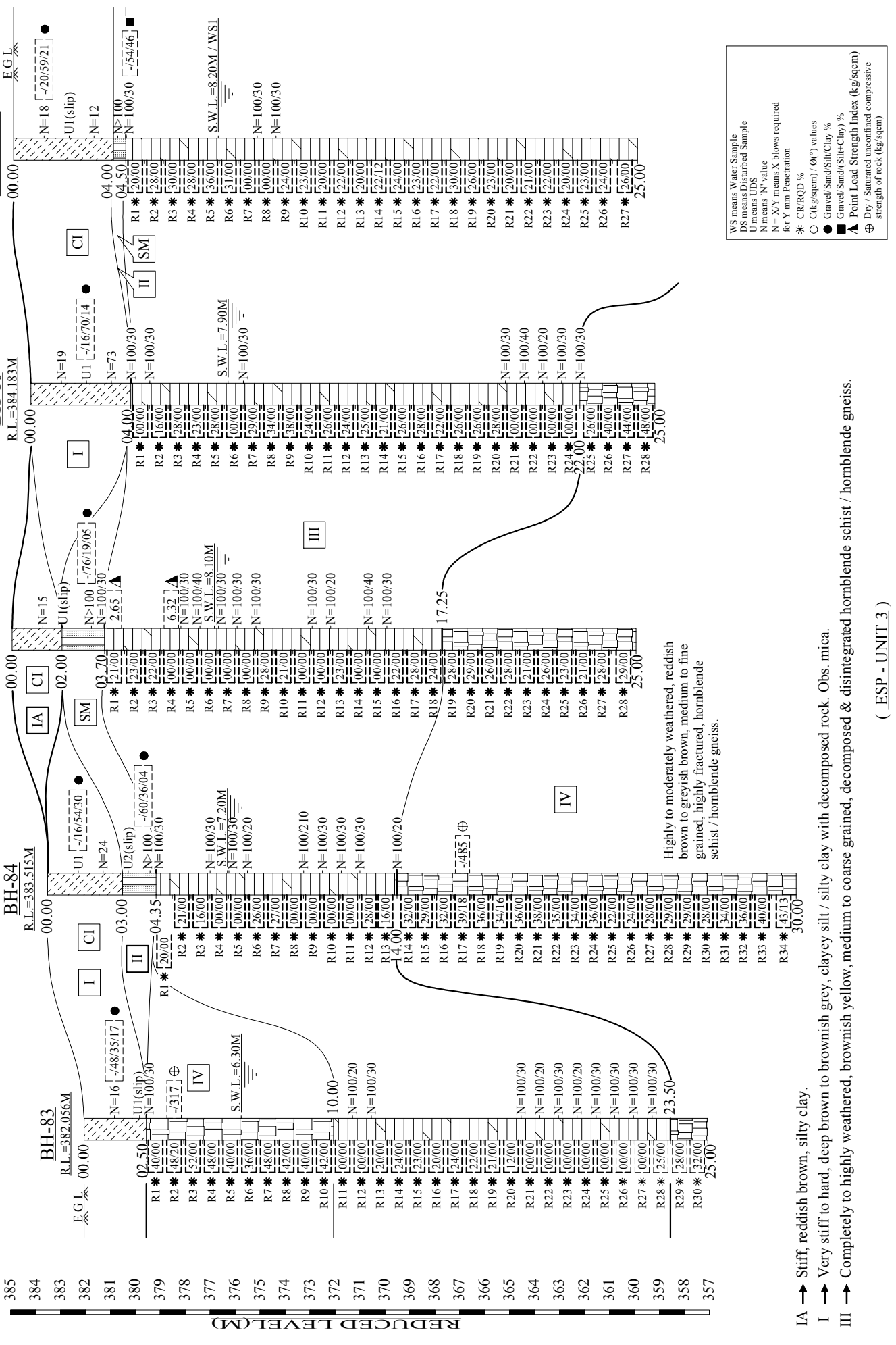
(ESP - UNIT 1)

FIG. 2.19 : GENERALIZED SOIL PROFILE



(ESP - UNIT 2)

FIG. 2.20 : GENERALIZED SOIL PROFILE



(ESP - UNIT 3)

FIG. 2.21 : GENERALIZED SOIL PROFILE

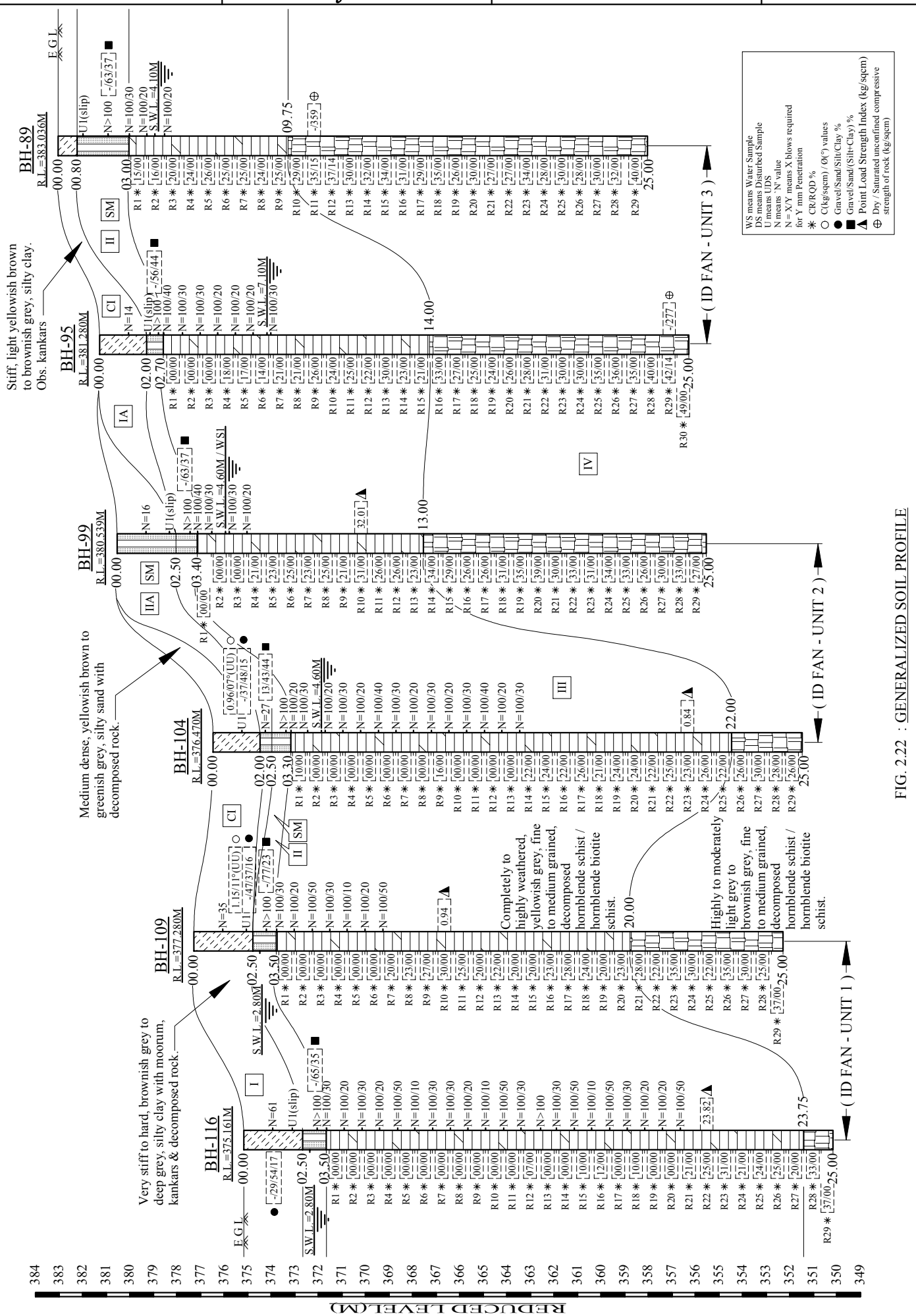


FIG. 2.22 : GENERALIZED SOIL PROFILE

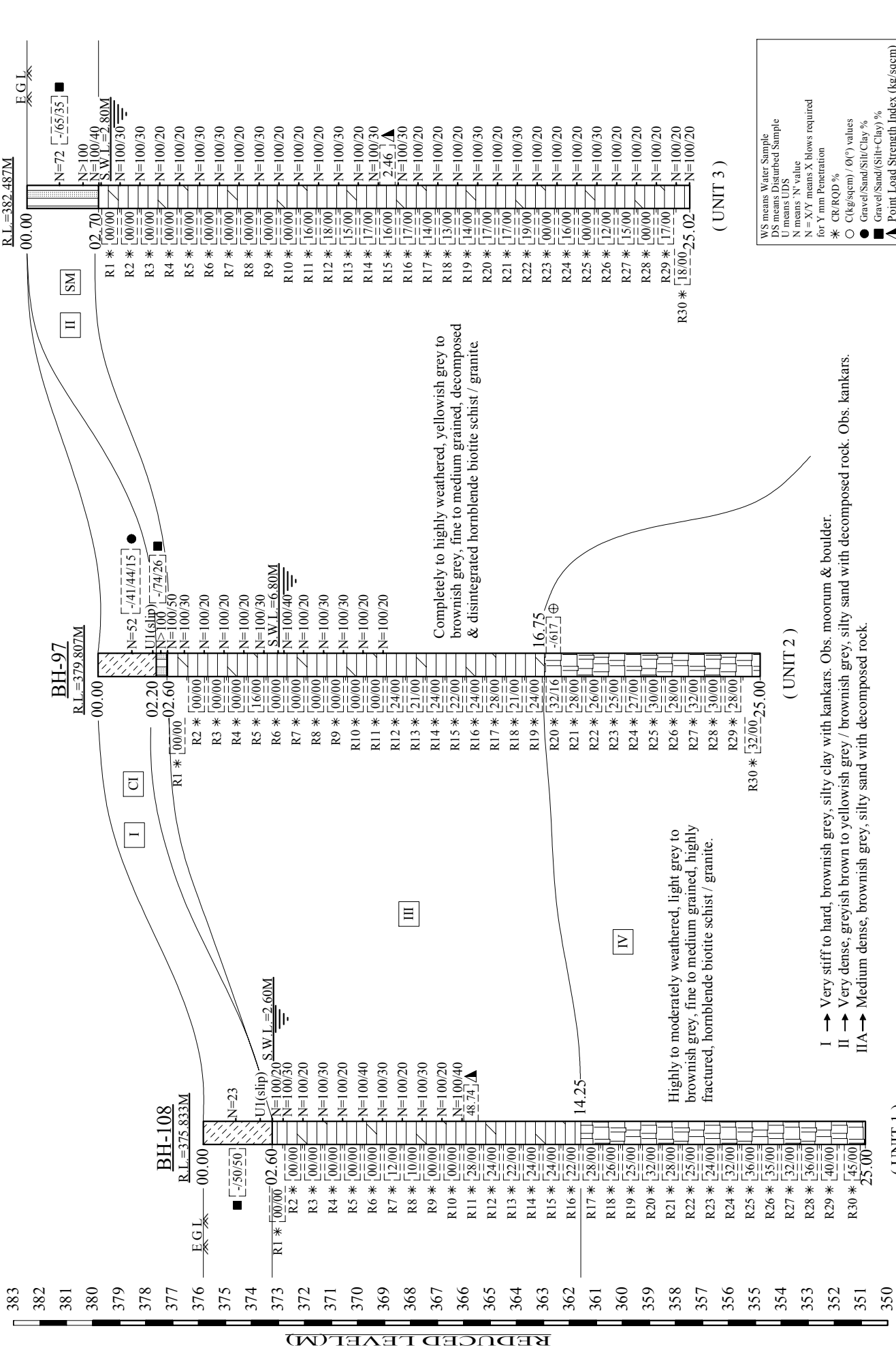
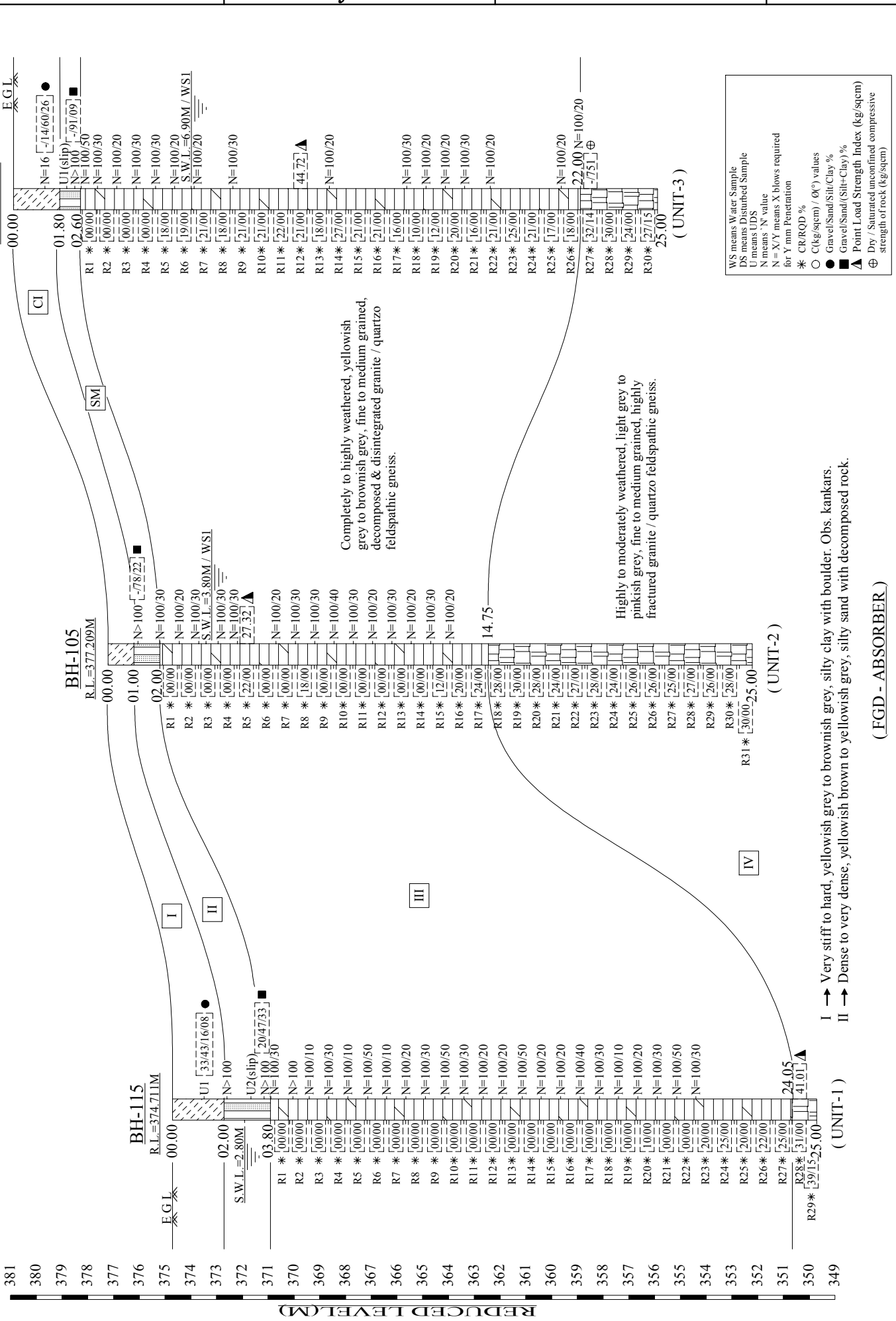


FIG. 2.23 : GENERALIZED SOIL PROFILE



(FGD - ABSORBER)

FIG. 2.24 : GENERALIZED SOIL PROFILE

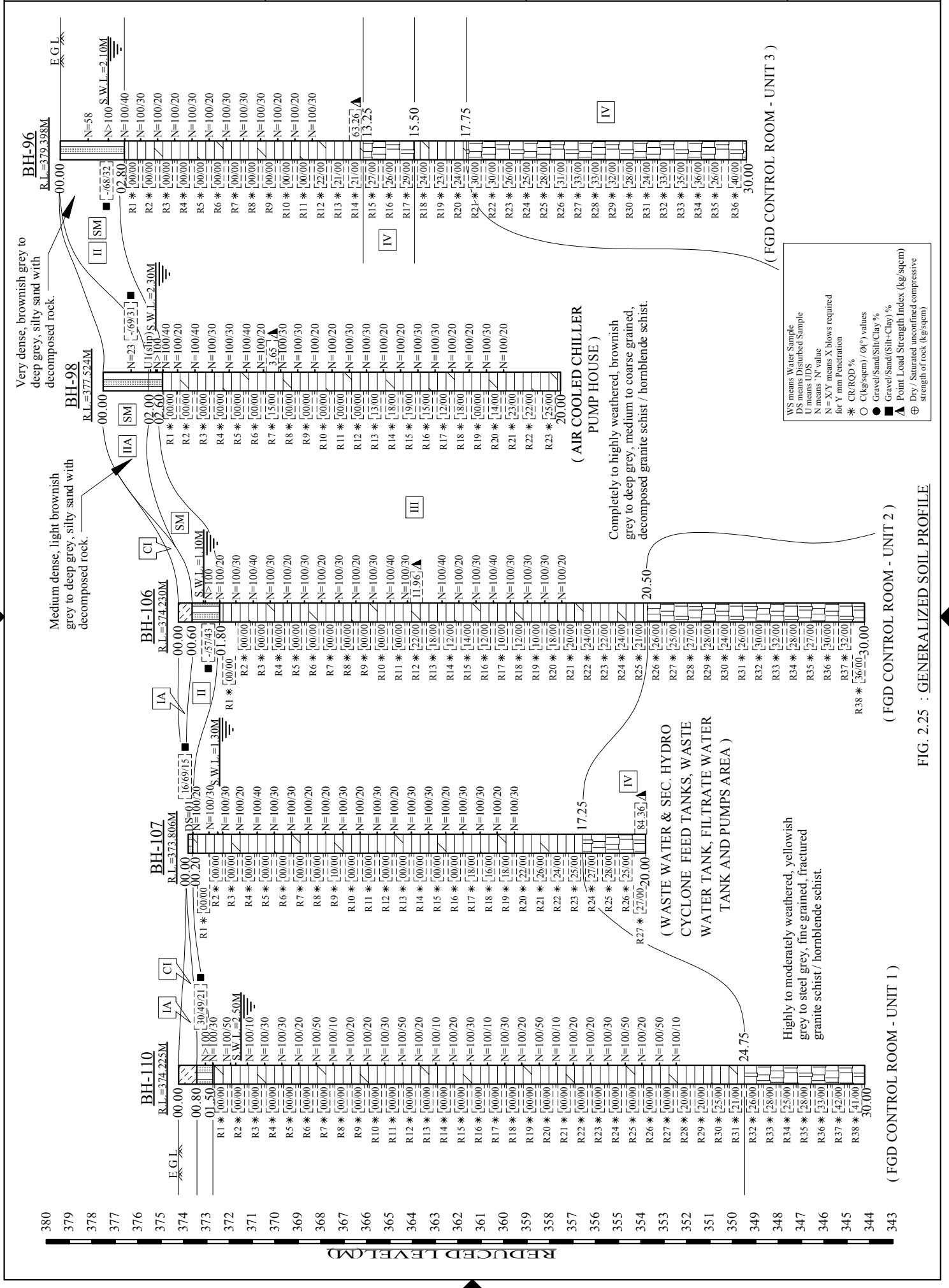
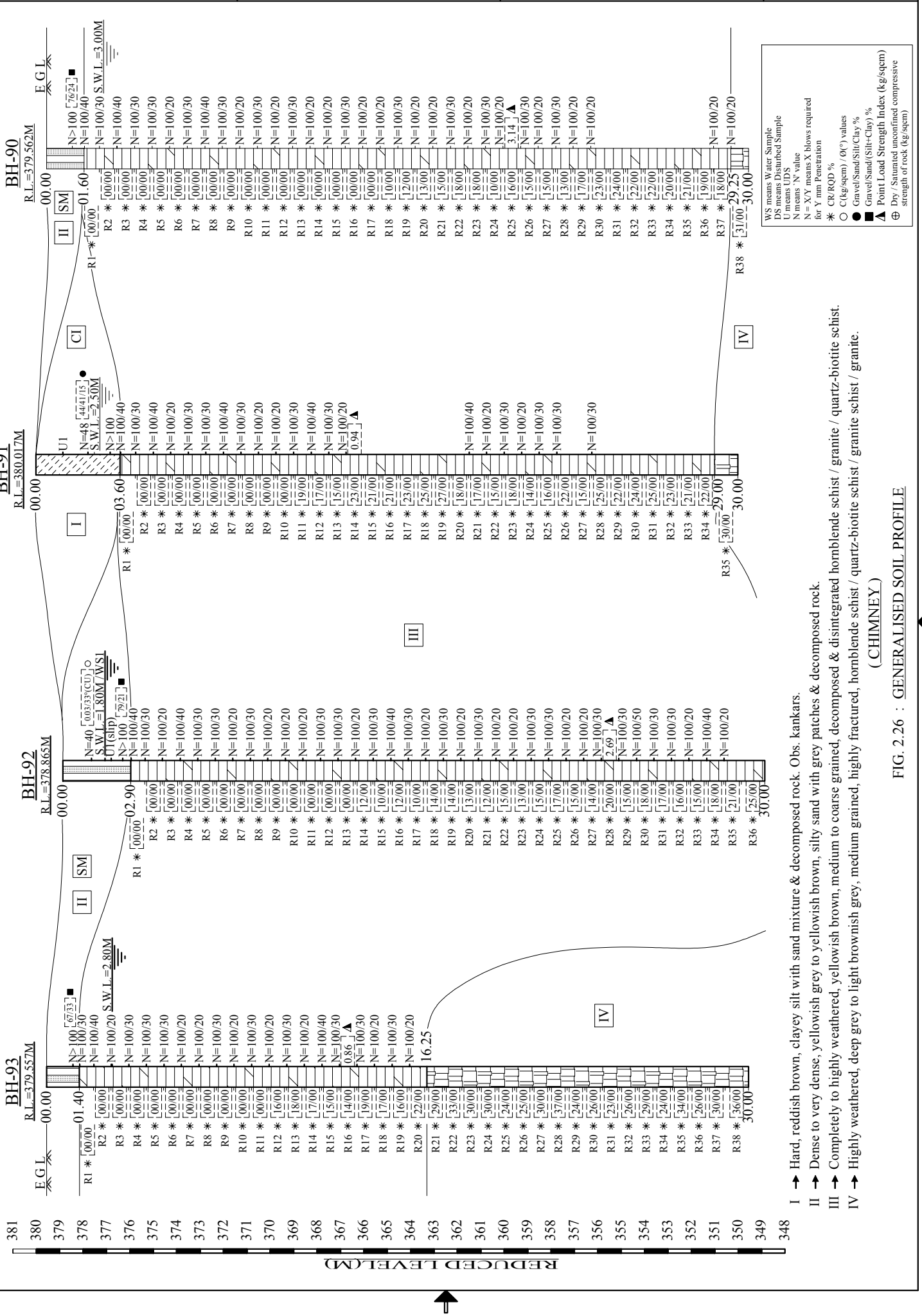
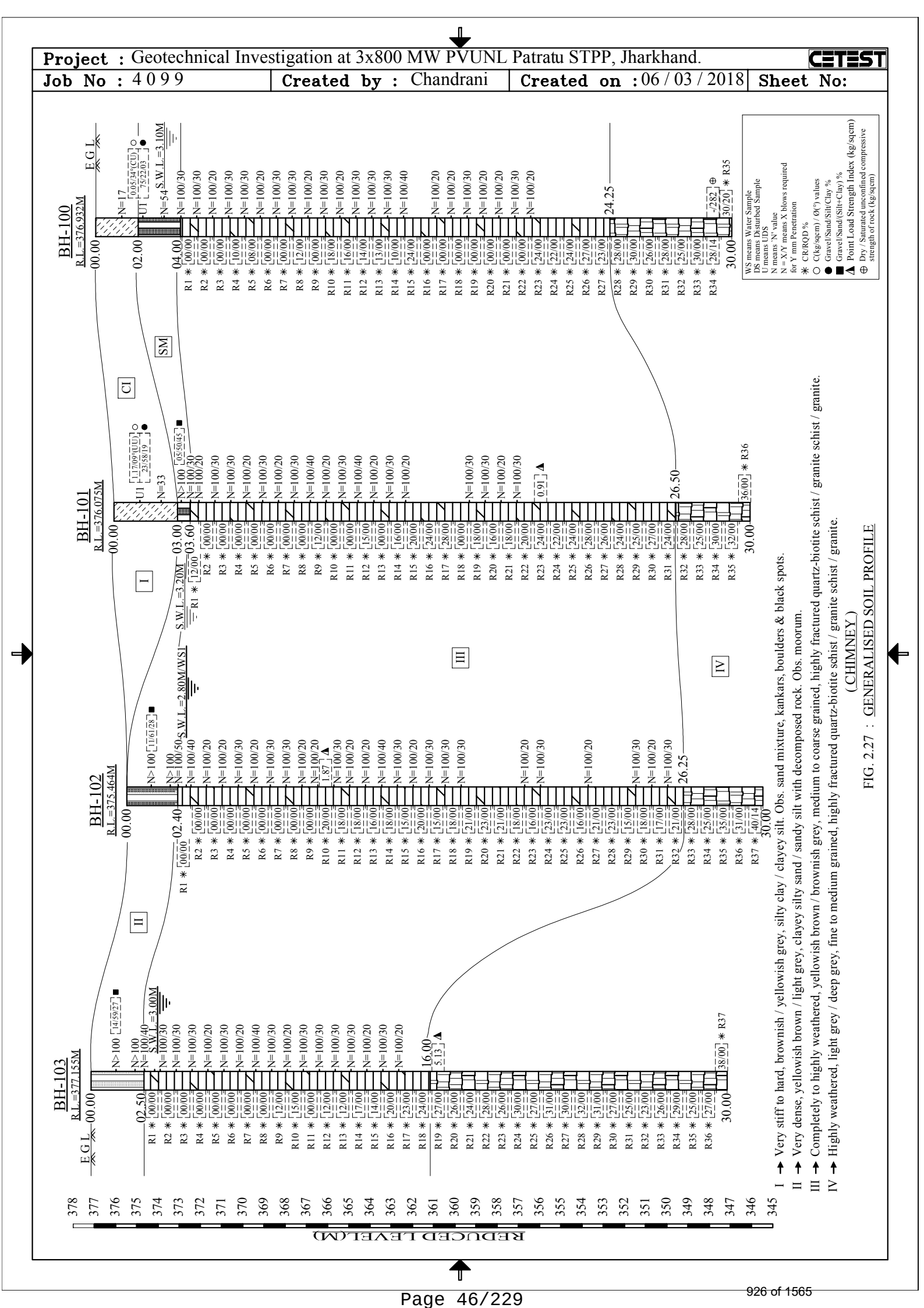


FIG. 2.25 : GENERALIZED SOIL PROFILE



(CHIMNEY)

FIG. 2.26 : GENERALISED SOIL PROFILE



(CHIMNEY)

FIG. 2.27 : GENERALISED SOIL PROFILE

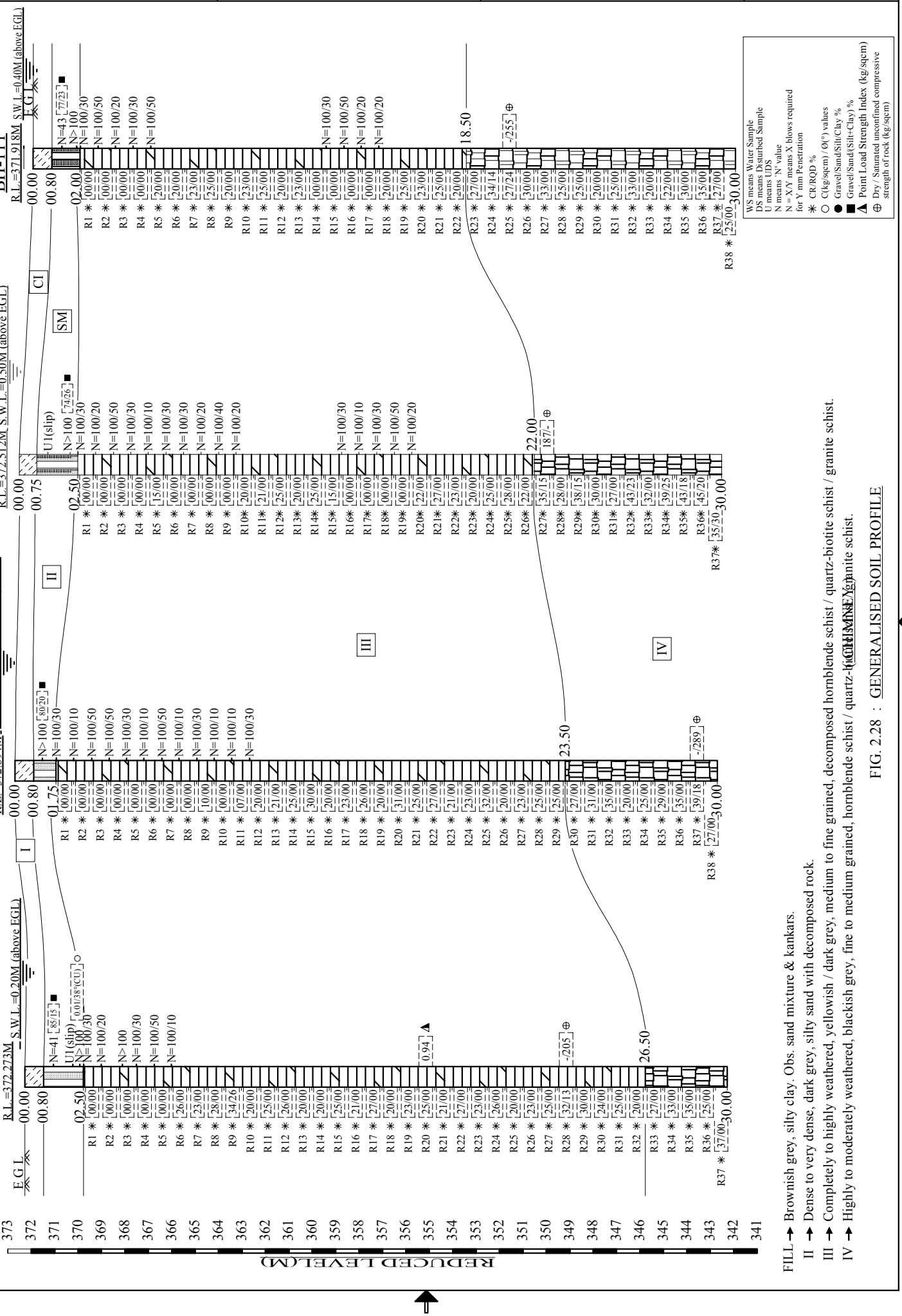


FIG. 2.28 : GENERALISED SOIL PROFILE

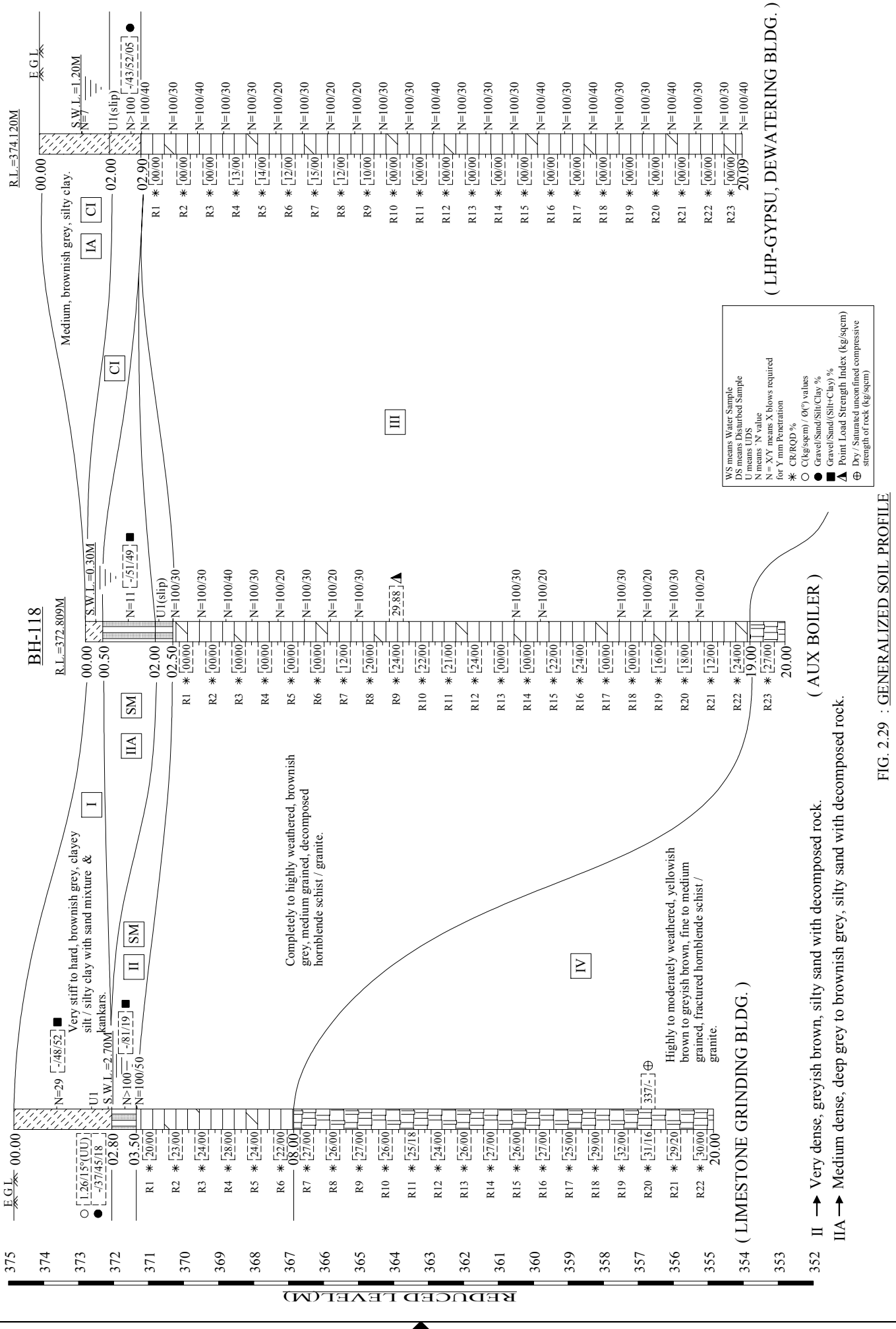


FIG. 2.29 : GENERALIZED SOIL PROFILE

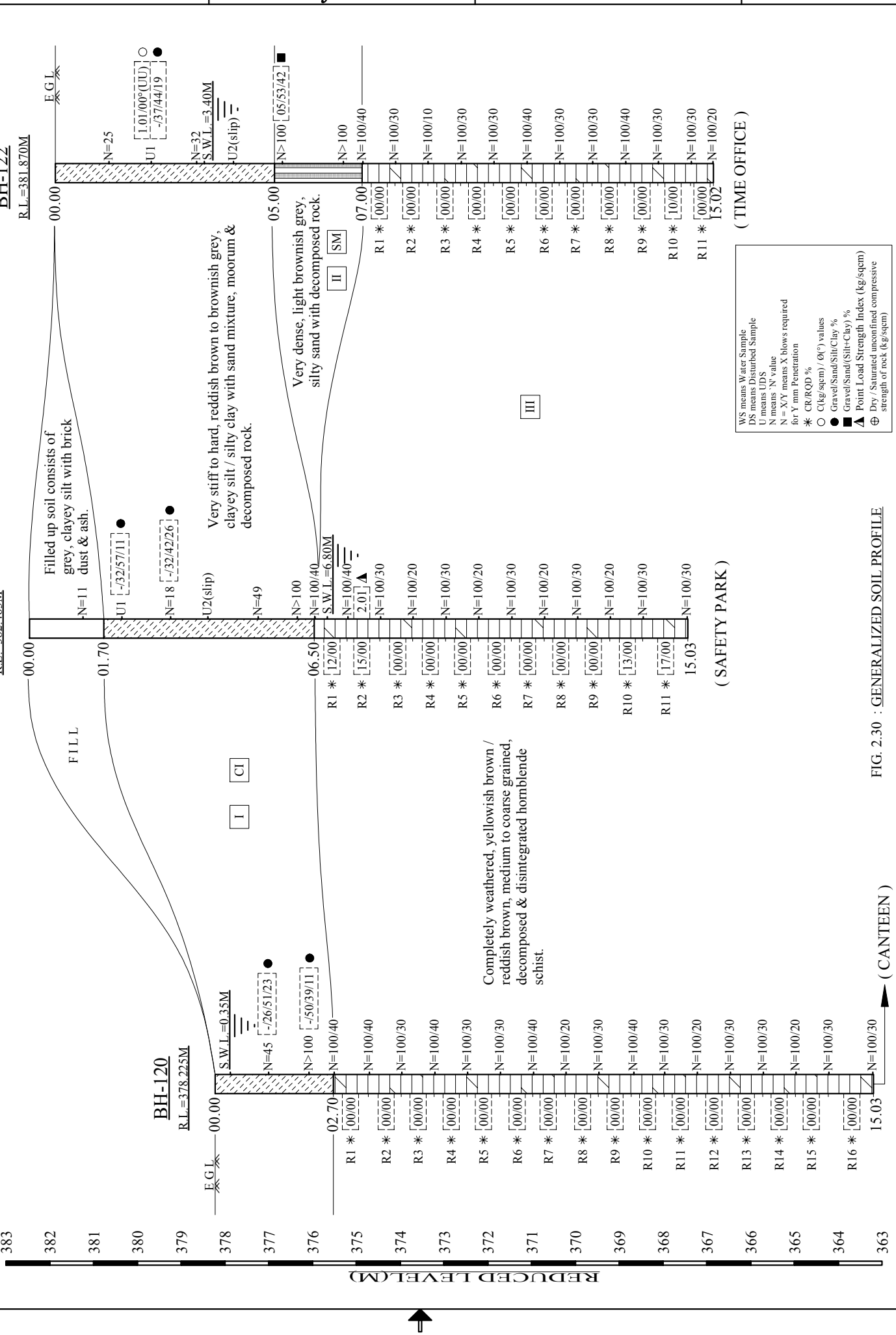


FIG. 2.30 : GENERALIZED SOIL PROFILE

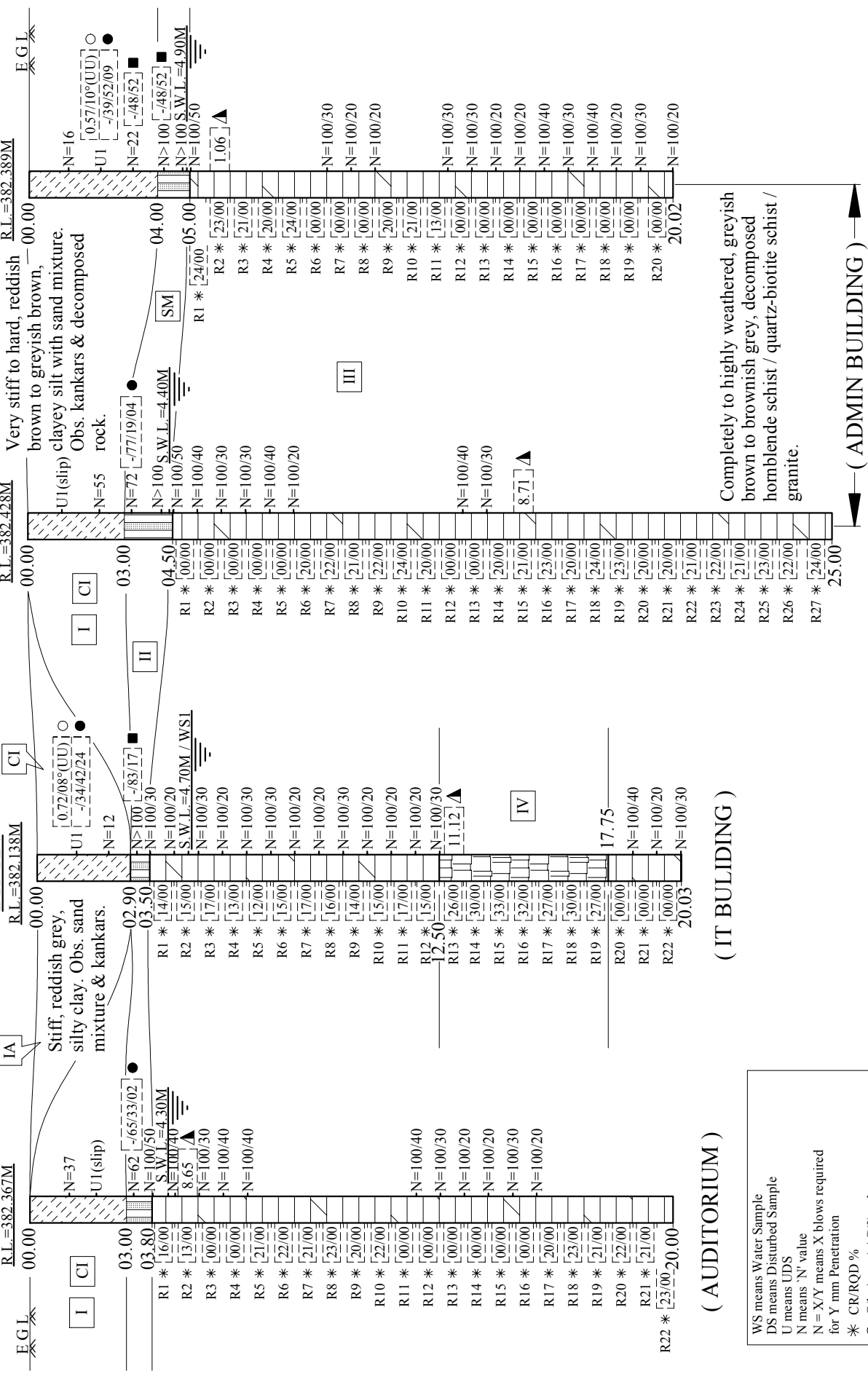


FIG. 2.31 : GENERALIZED SOIL PROFILE

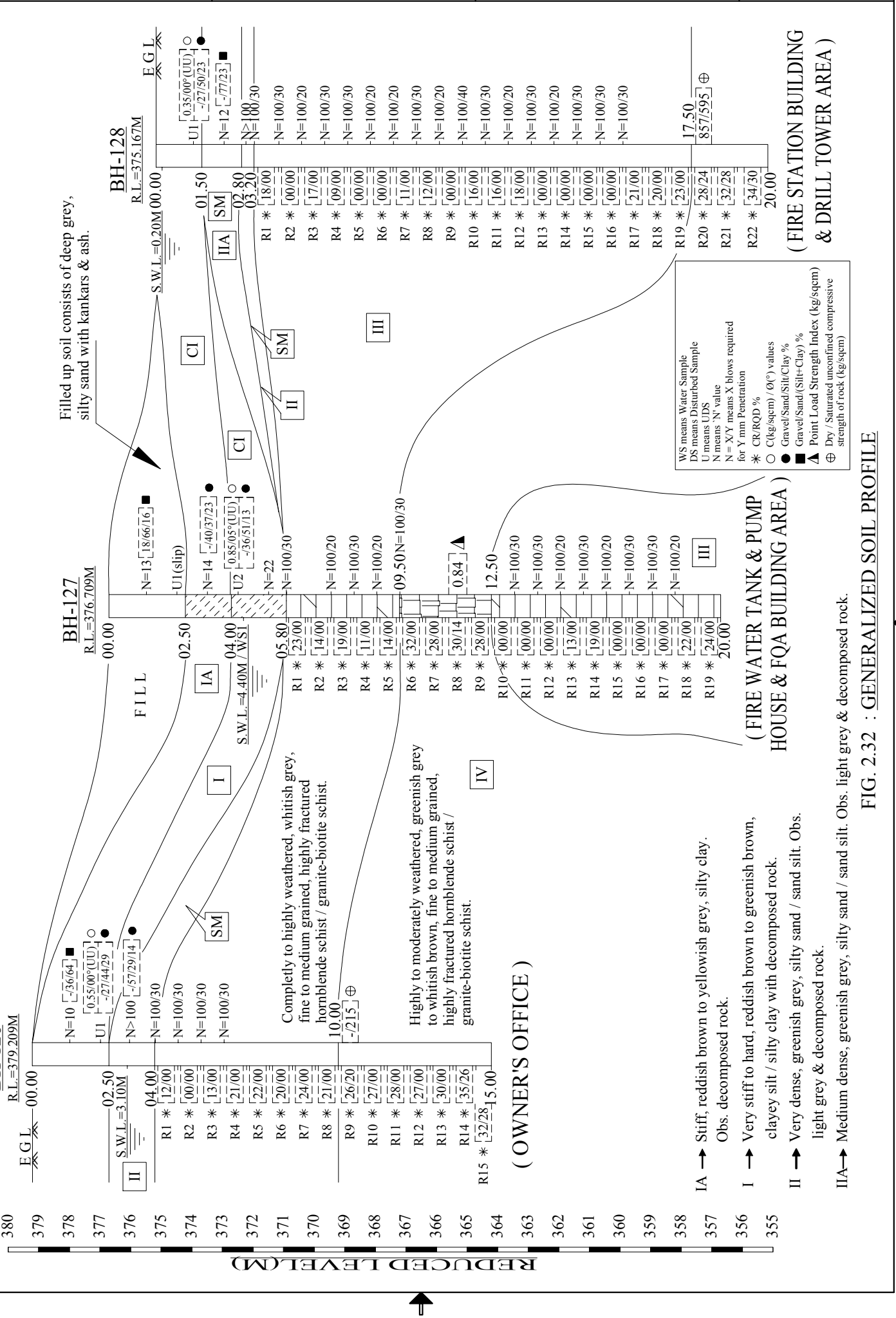


FIG. 2.32 : GENERALIZED SOIL PROFILE

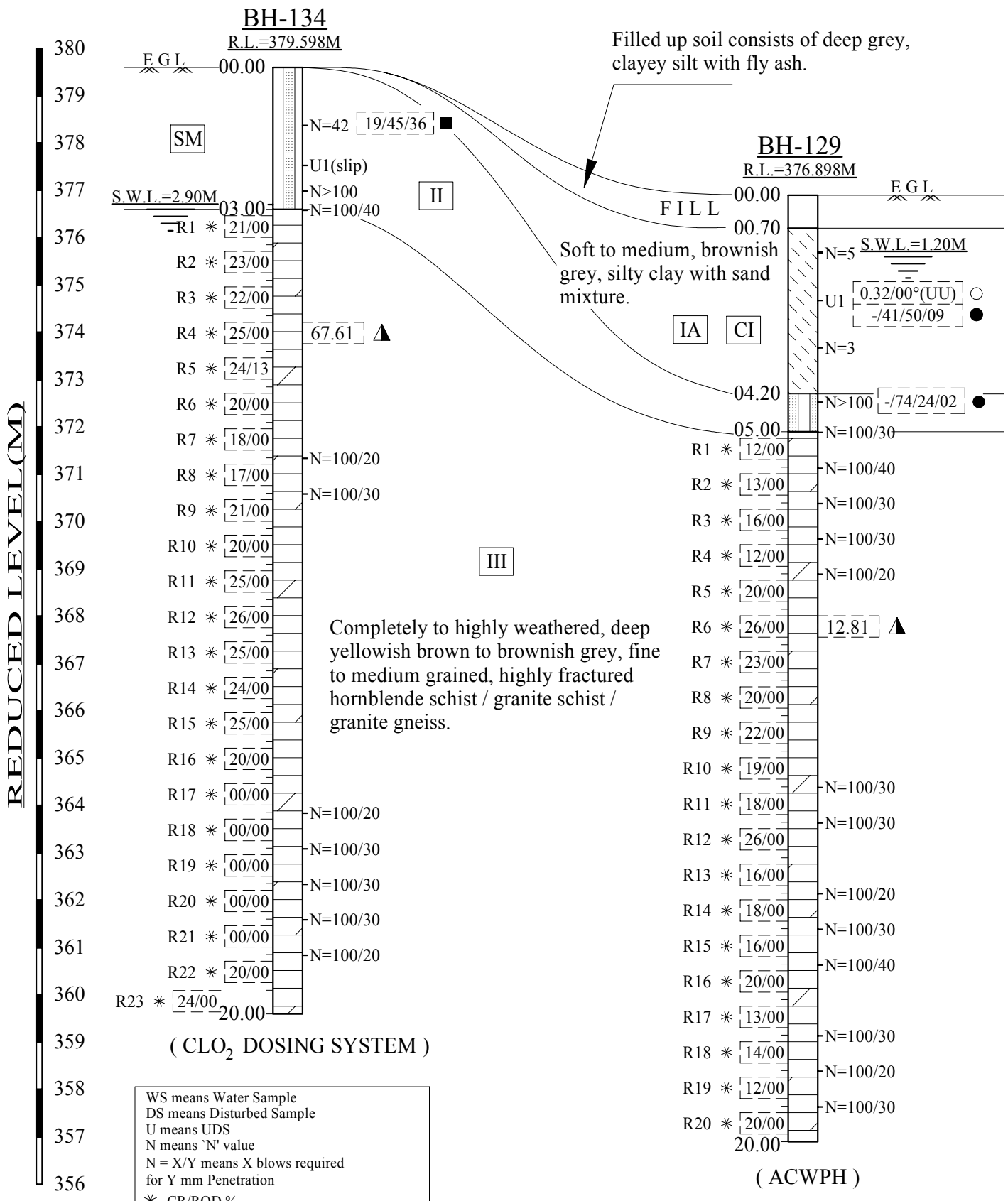
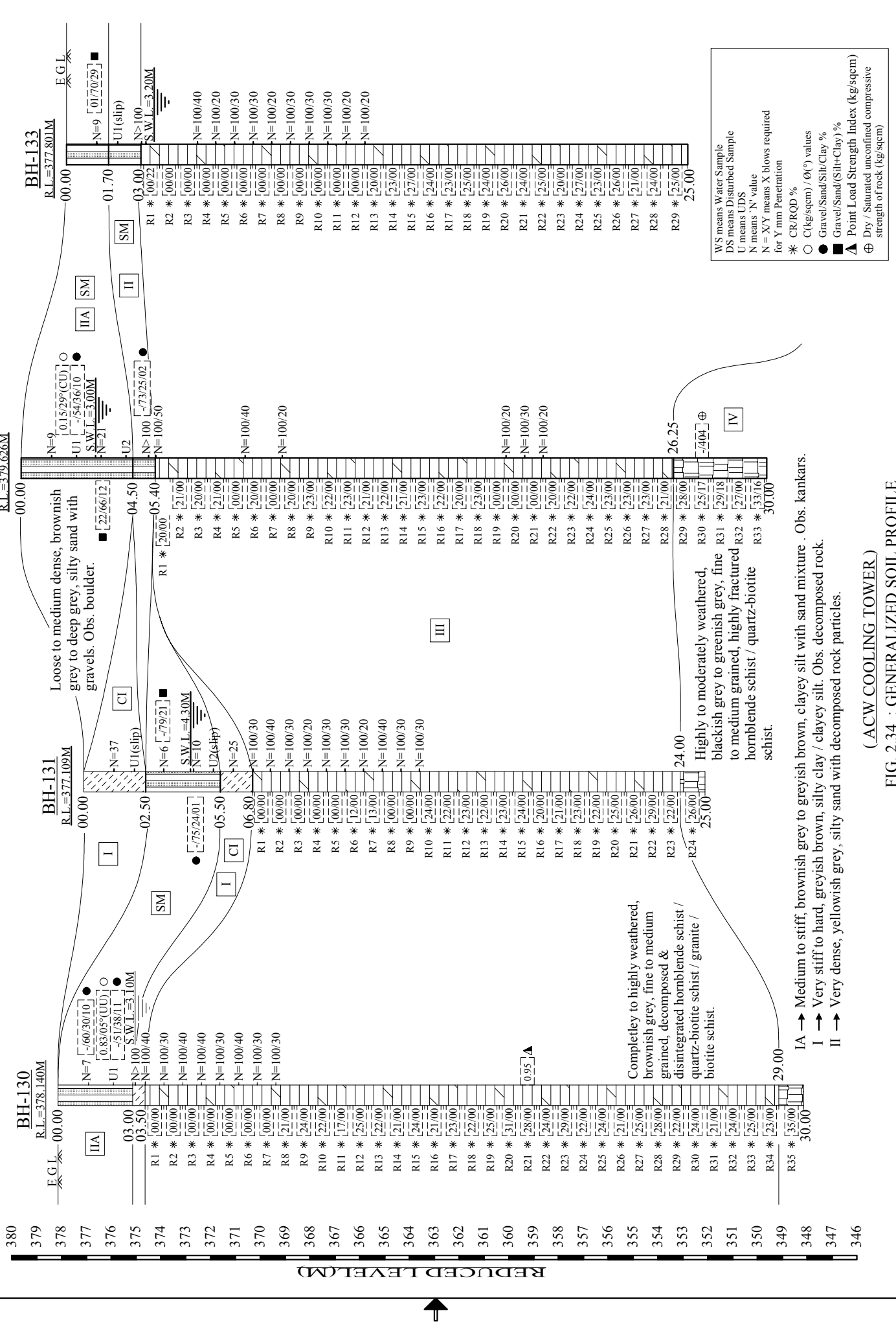


FIG. 2.33 : GENERALIZED SOIL PROFILE



(ACW COOLING TOWER)

FIG. 2.34 : GENERALIZED SOIL PROFILE

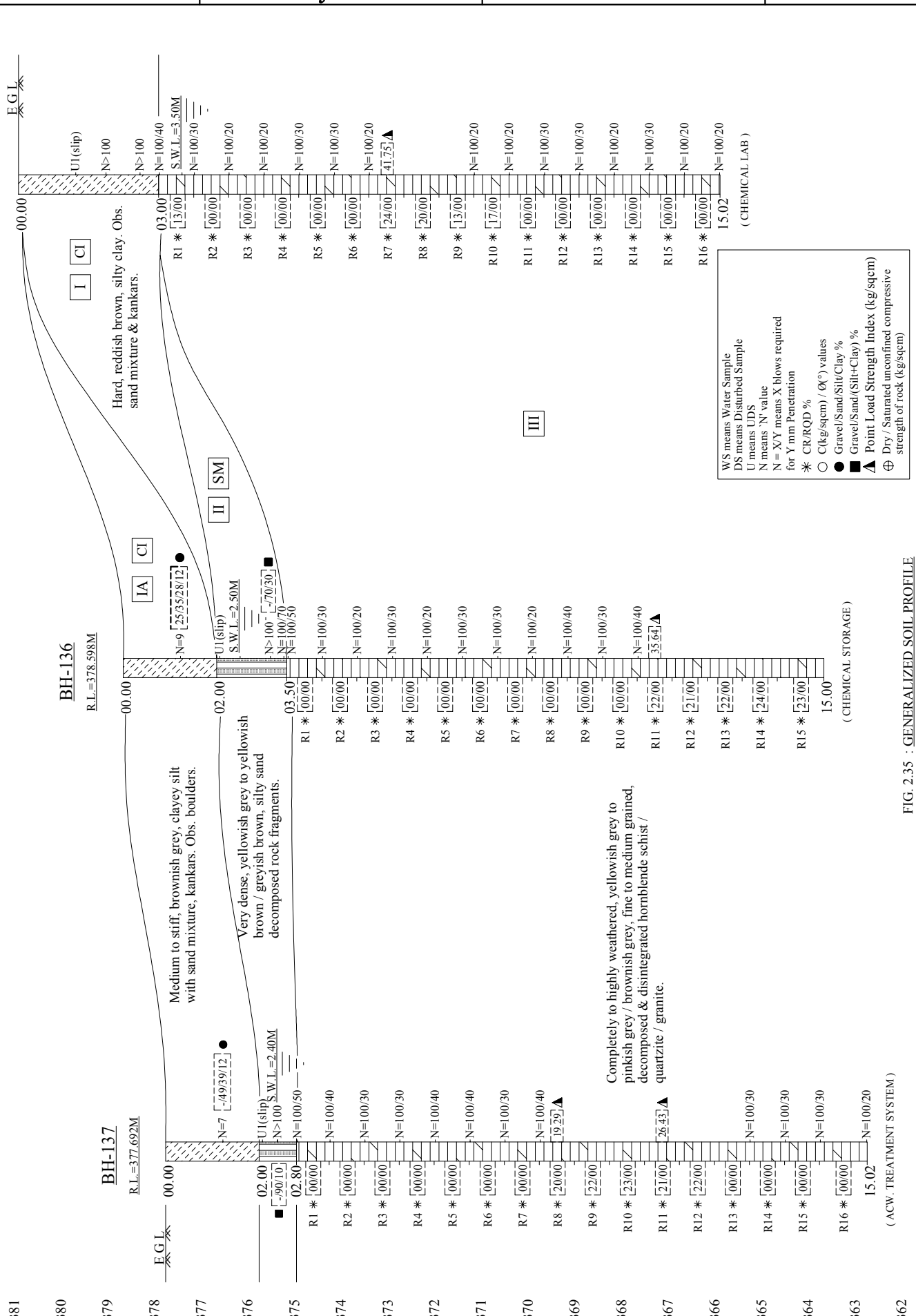


FIG. 2.35 : GENERALIZED SOIL PROFILE

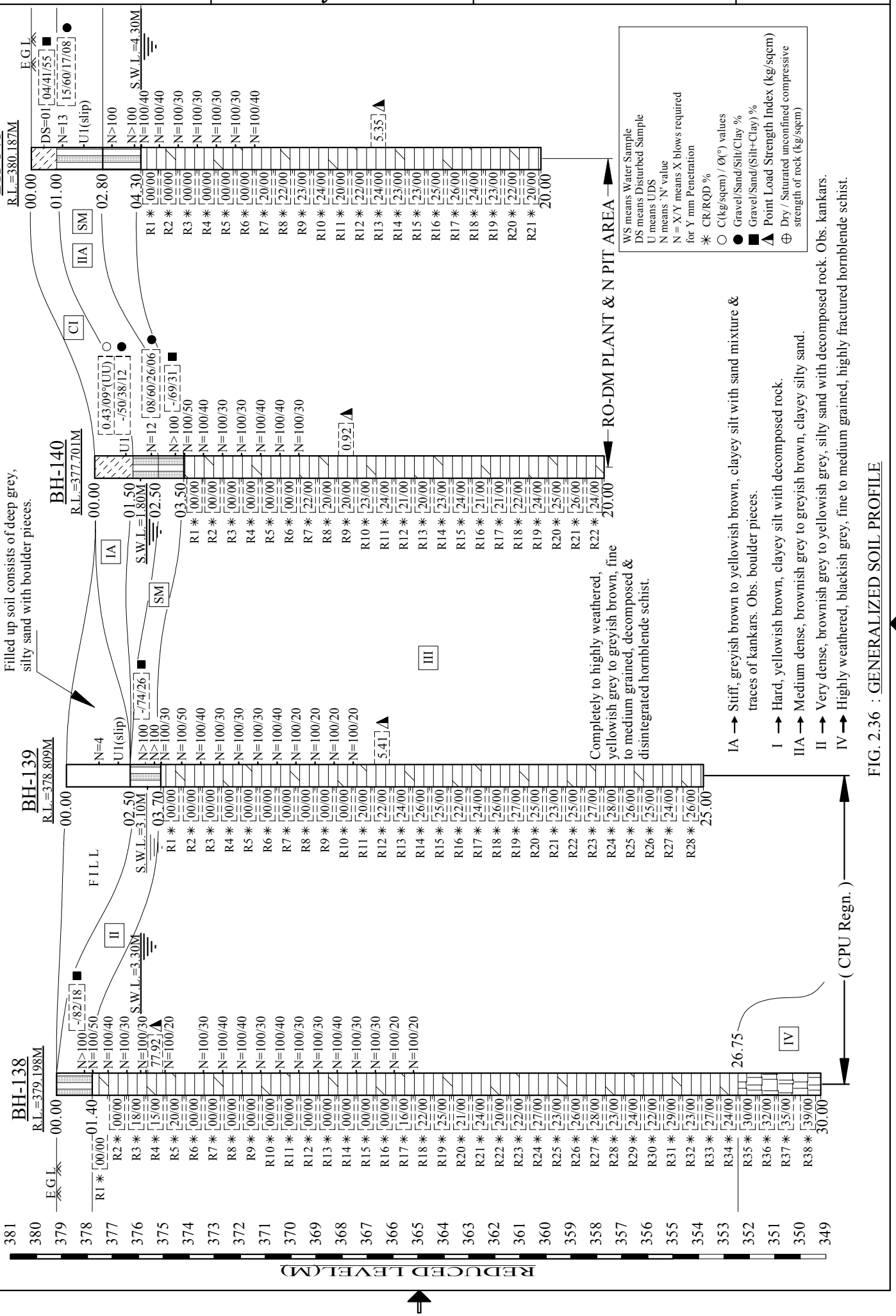
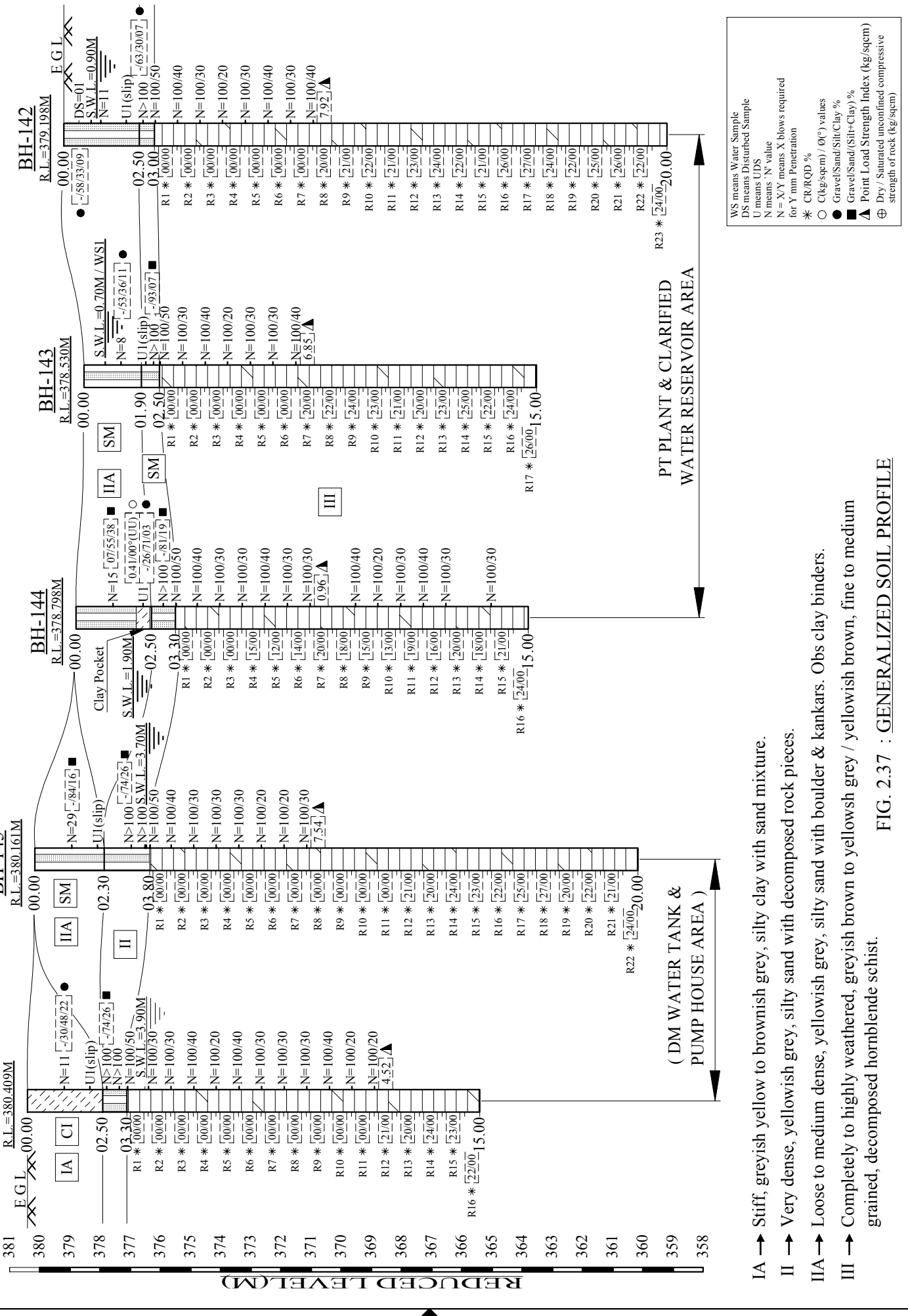


FIG. 2.36 : GENERALIZED SOIL PROFILE



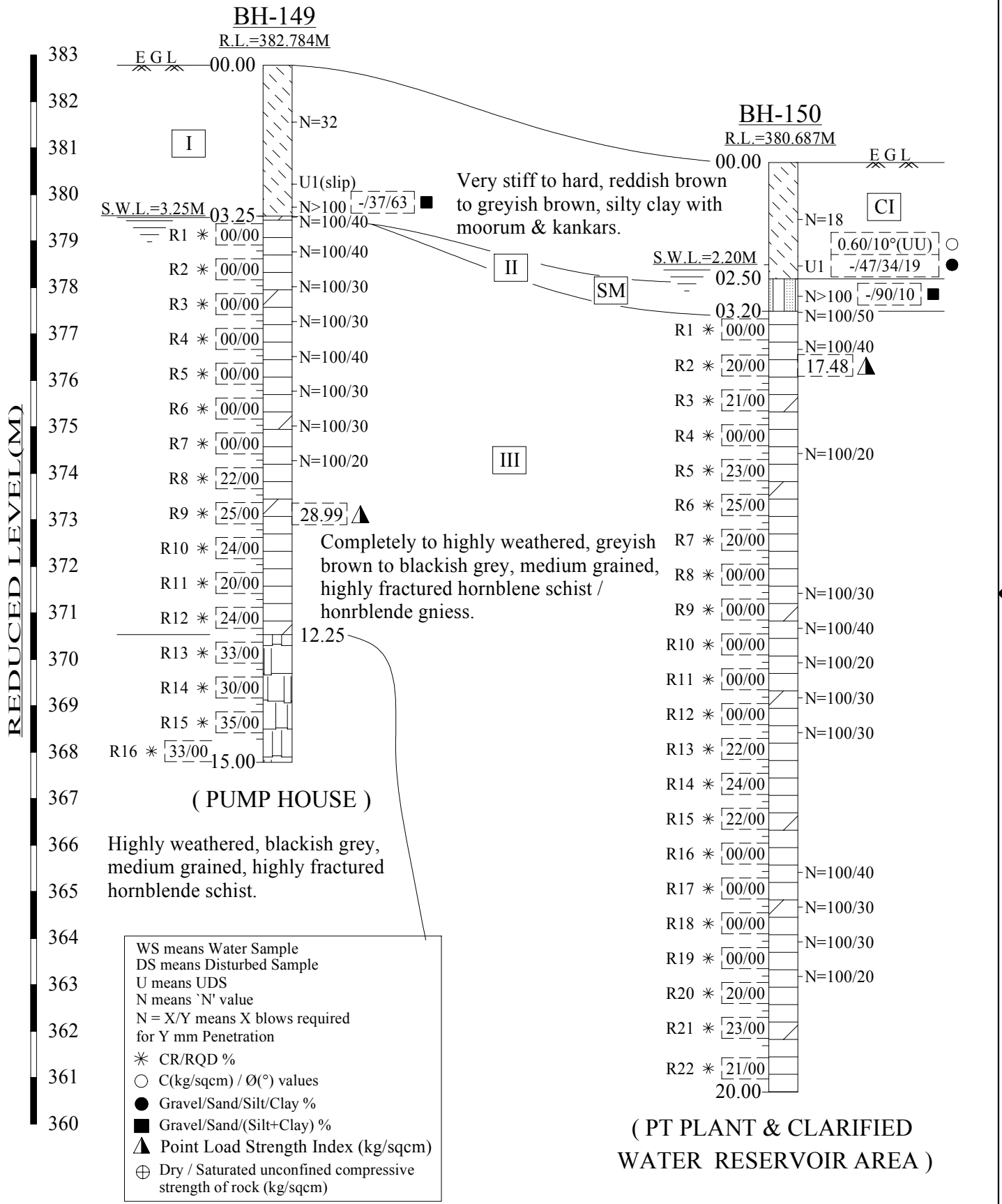
IA → Stiff, greyish yellow to brownish grey, silty clay with sand mixture.

II → Very dense, yellowish grey, silty sand with decomposed rock pieces.

IIA → Loose to medium dense, yellowish grey, silty sand with boulder & kankars. Obs clay binders.

III → Completely to highly weathered, greyish brown to yellowsh grey / yellowish brown, fine to medium grained, decomposed hornblende schist.

FIG. 2.37 : GENERALIZED SOIL PROFILE



II → Very dense, deep grey, silty sand with decomposed rock.

FIG. 2.38 : GENERALIZED SOIL PROFILE

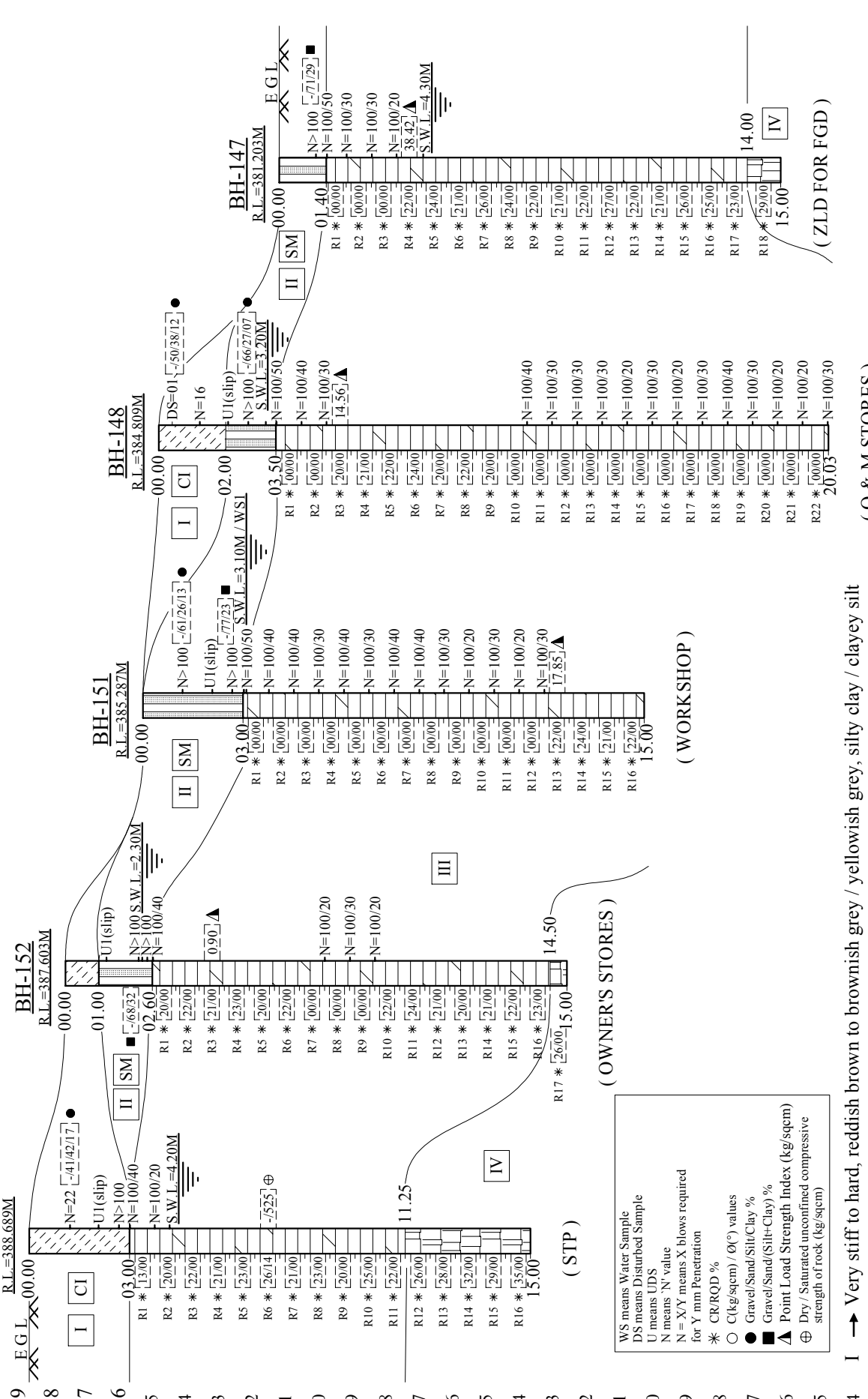
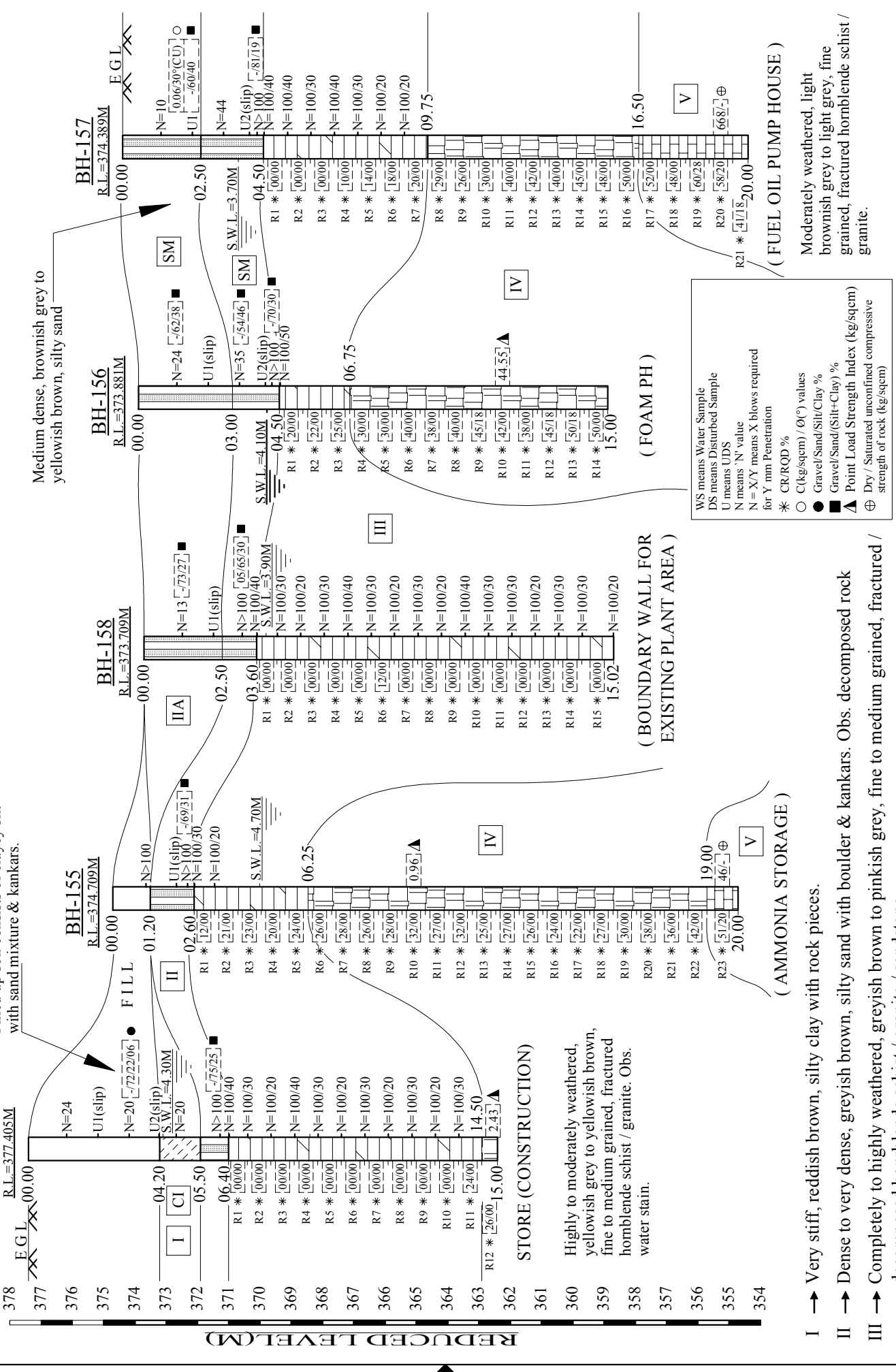


FIG. 2.39 : GENERALIZED SOIL PROFILE

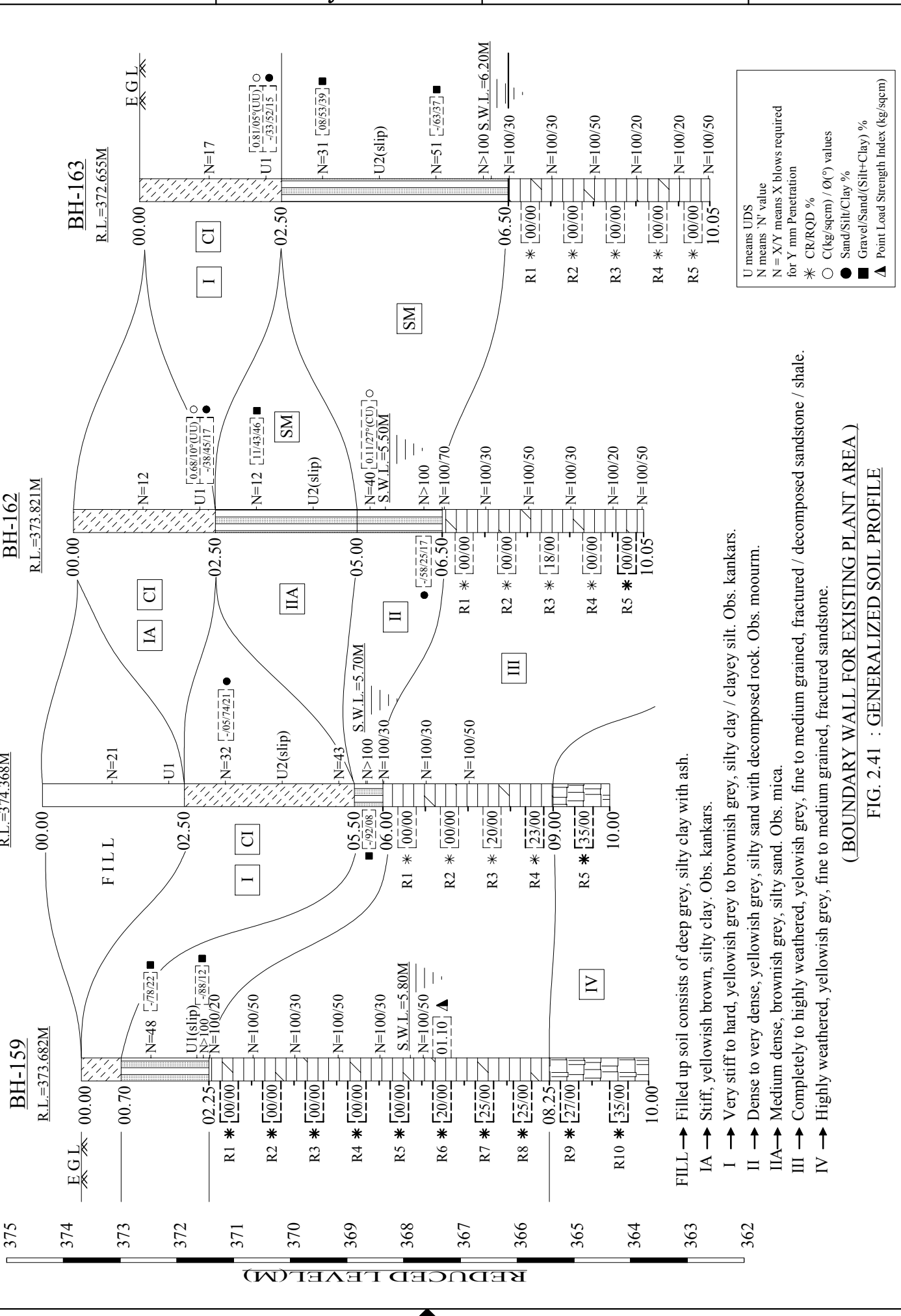


I → Very stiff, reddish brown, silty clay with rock pieces.

II → Dense to very dense, greyish brown, silty sand with boulder & kankars. Obs. decomposed rock

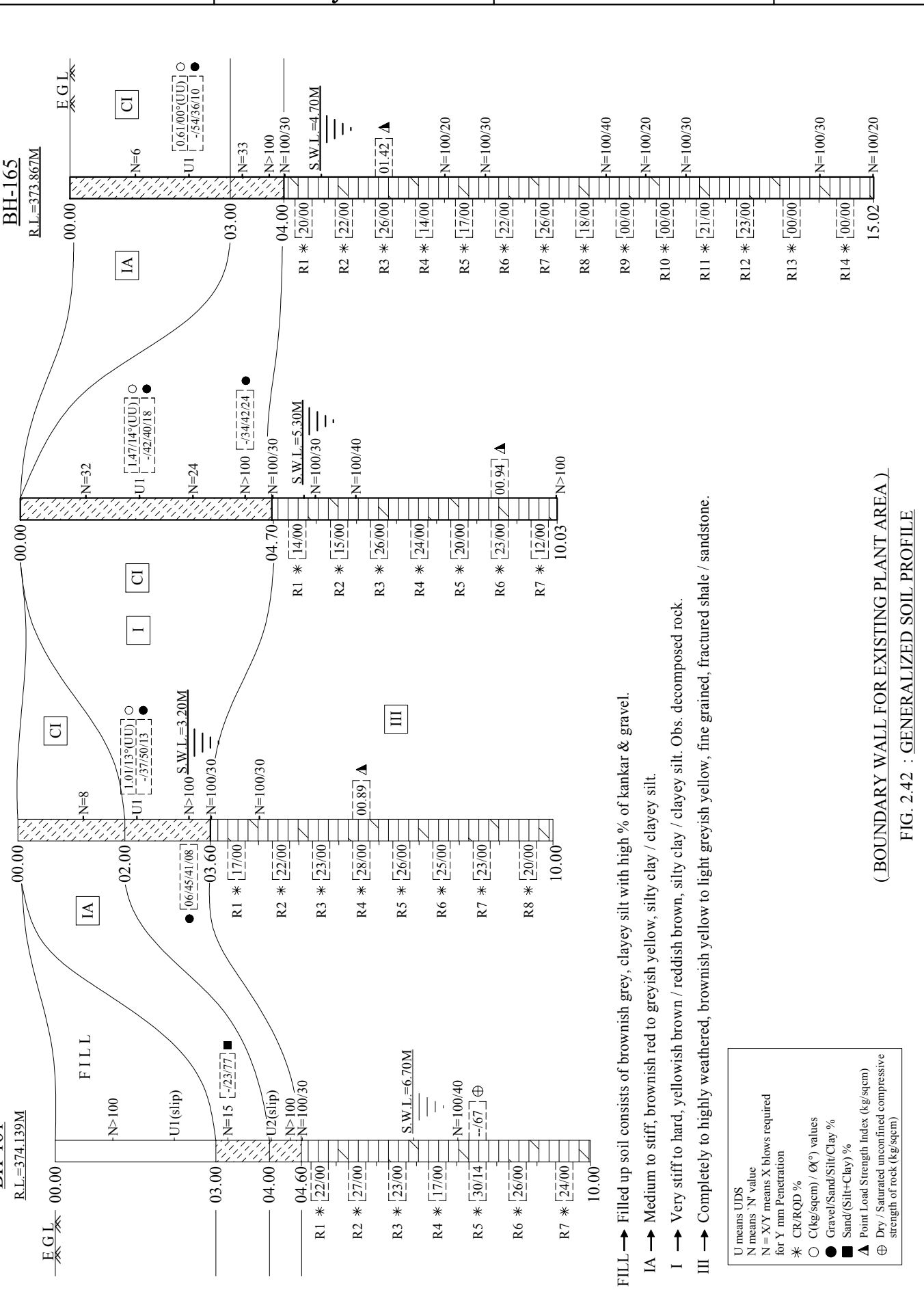
III → Completely to highly weathered, greyish brown to pinkish grey, fine to medium grained, fractured / decomposed hornblende schist / granite / sandstone.

FIG. 2.40 : GENERALIZED SOIL PROFILE



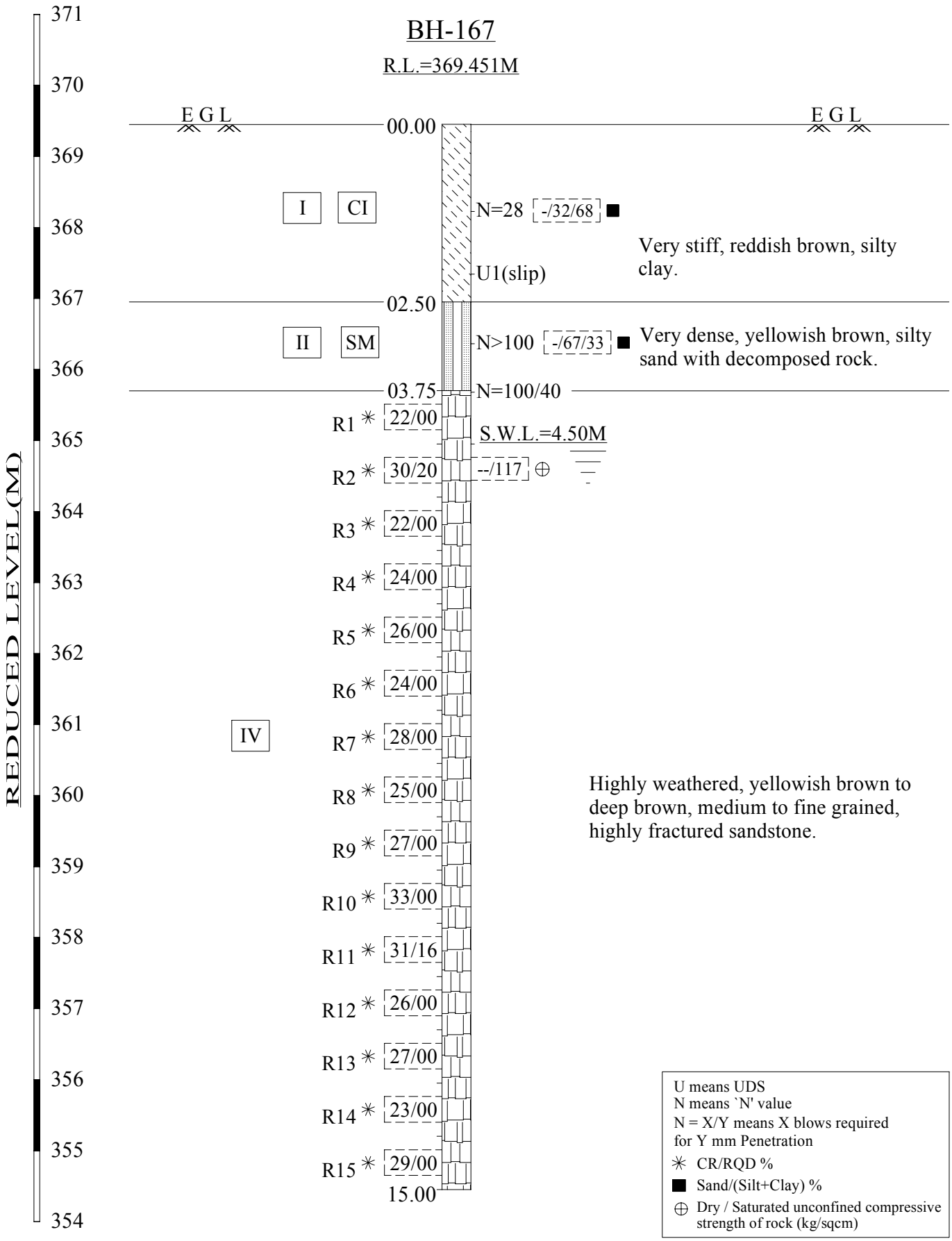
(BOUNDARY WALL FOR EXISTING PLANT AREA)

FIG. 2.41 : GENERALIZED SOIL PROFILE



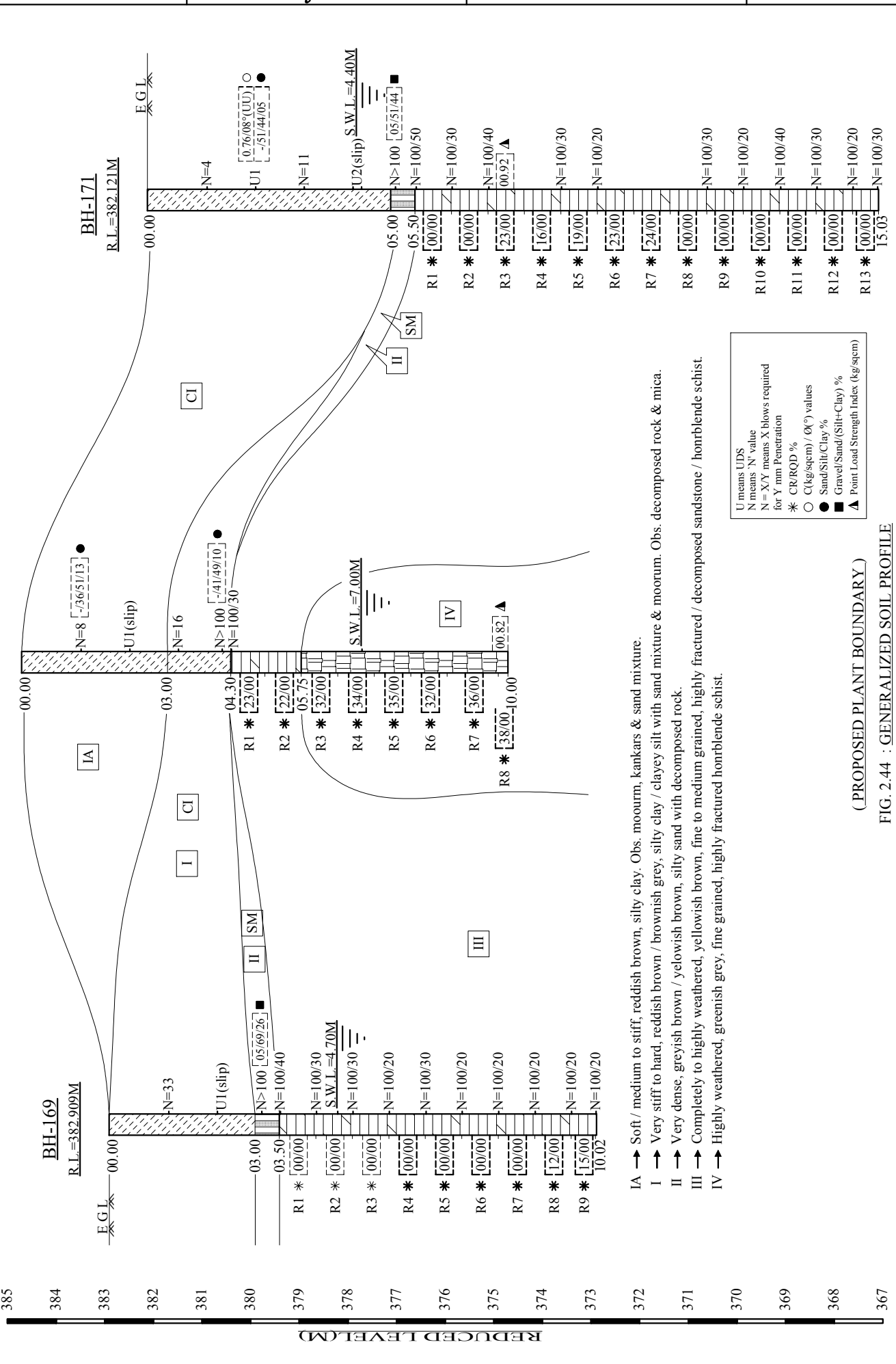
(BOUNDARY WALL FOR EXISTING PLANT AREA)

FIG. 2.42 : GENERALIZED SOIL PROFILE



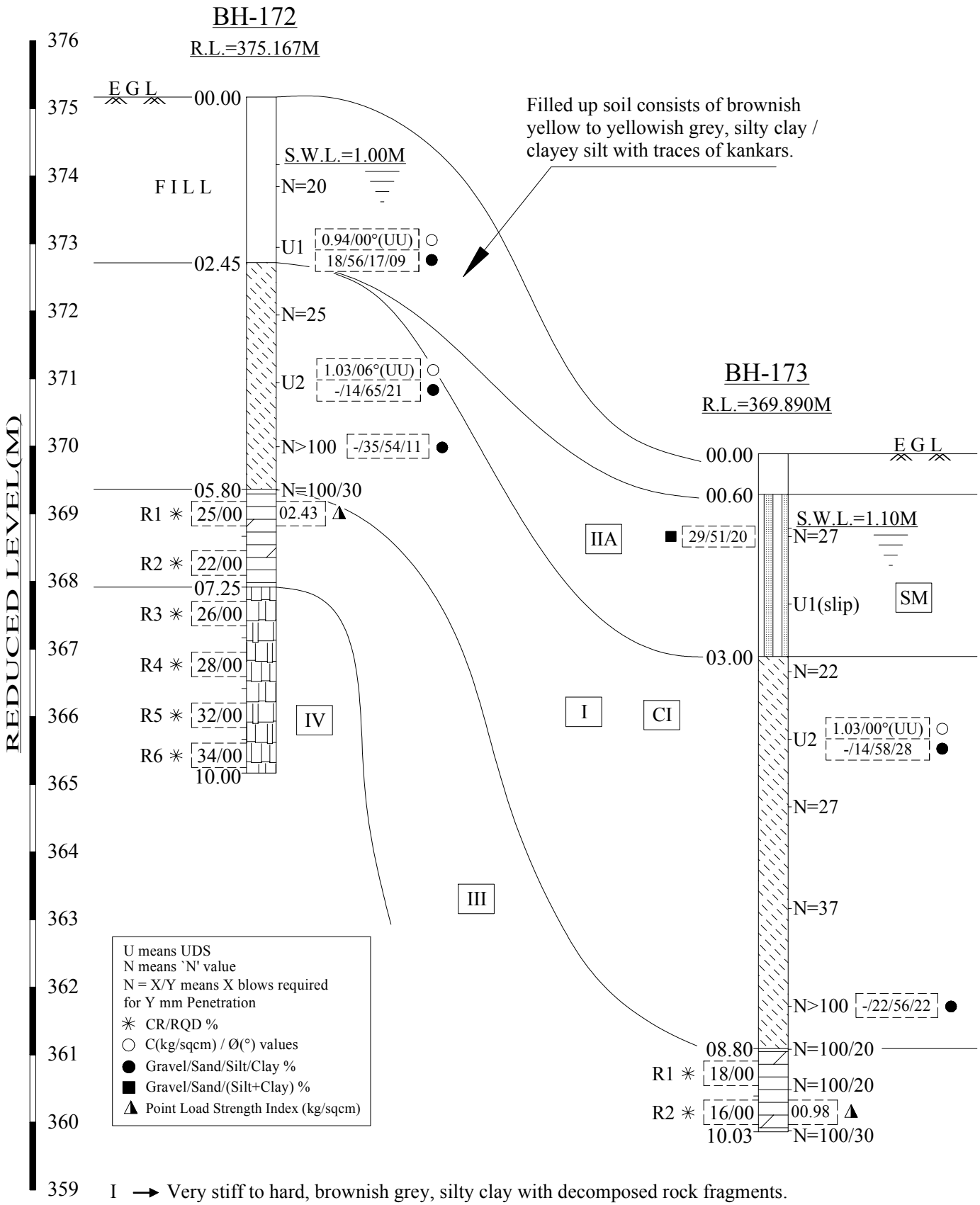
(HYDROGEN GENERATION PLANT)

FIG. 2.43 : GENERALIZED SOIL PROFILE



(PROPOSED PLANT BOUNDARY)

FIG. 2.44 : GENERALIZED SOIL PROFILE



I → Very stiff to hard, brownish grey, silty clay with decomposed rock fragments.

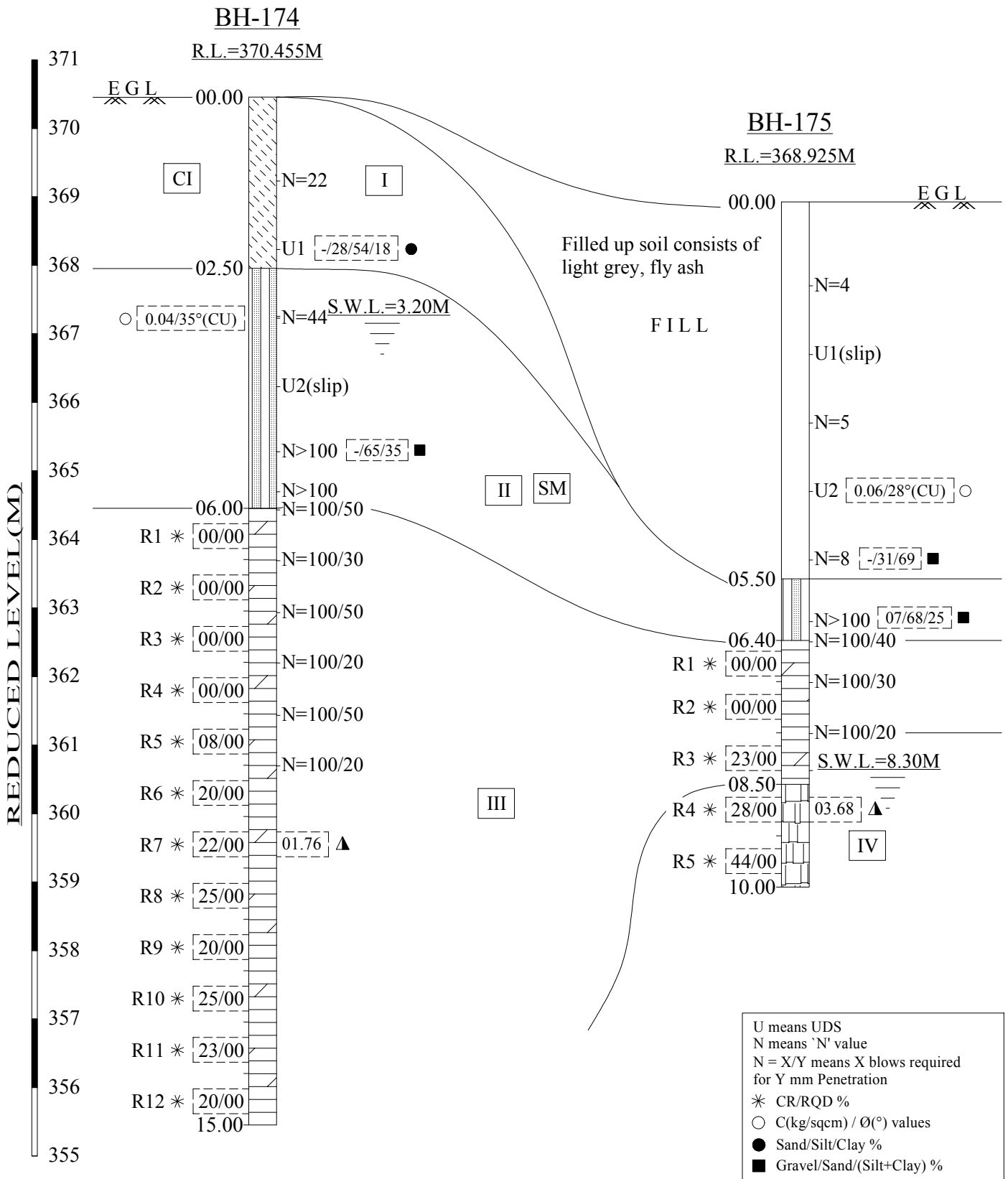
IIA → Medium dense, brownish grey, silty sand with moorum & kankars.

III → Completely to highly weathered, brownish grey, fine grained, highly fractured sandstone.

IV → Highly weathered, brownish grey, fine grained, highly fractured sandstone.

(PROPOSED PLANT BOUNDARY)

FIG. 2.45 : GENERALIZED SOIL PROFILE



I → Very stiff, yellowish grey, silty clay. Obs. kankars.

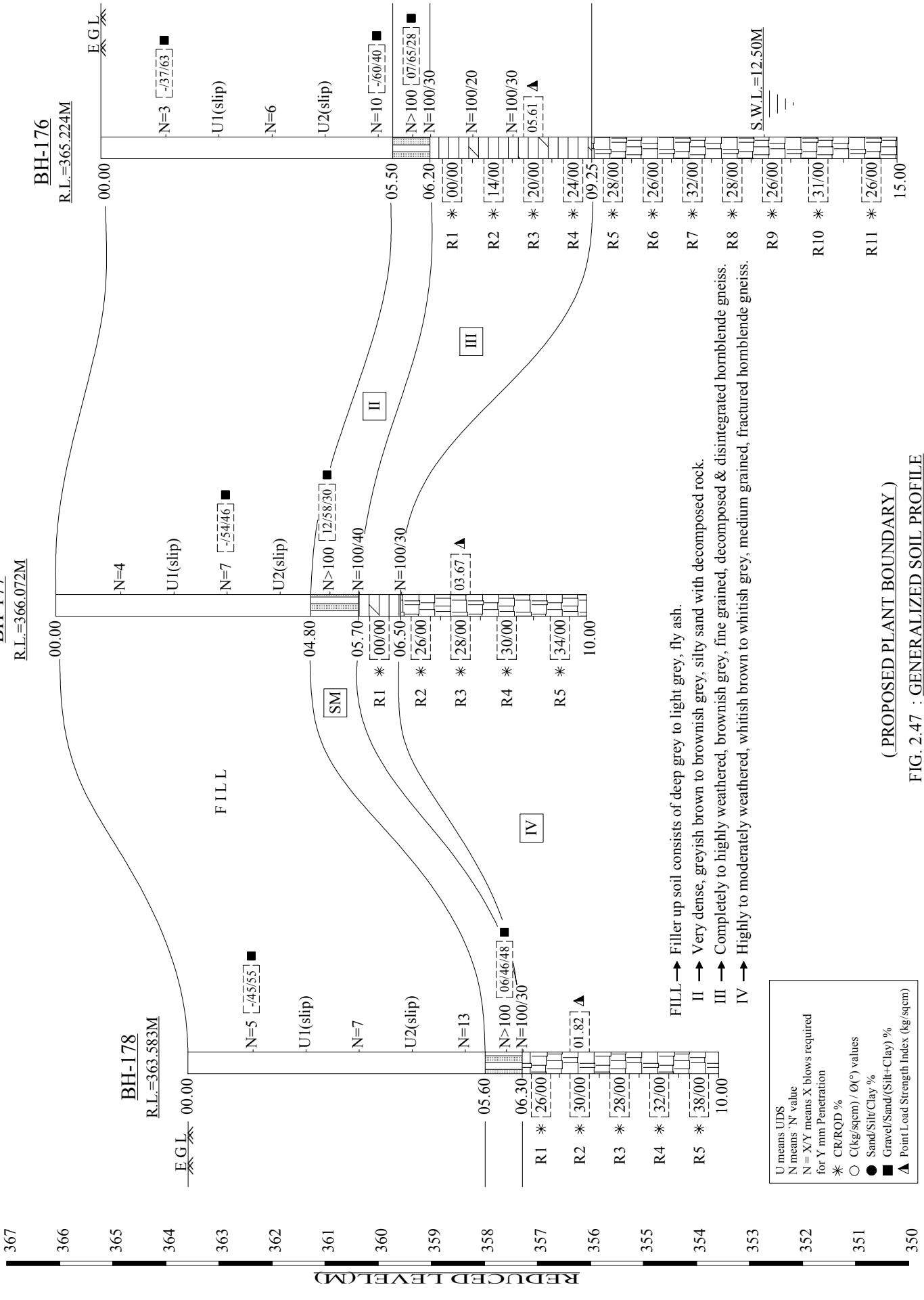
II → Dense to very dense, reddish grey to brownish grey, silty sand with decomposed rock.

III → Completely to highly weathered, reddish grey, fine to medium grained, decomposed & disintegrated sandstone / quartz-biotite-schist.

IV → Highly to moderately weathered, deep brownish grey, fine grained, highly fractured sandstone / quartz-biotite schist.

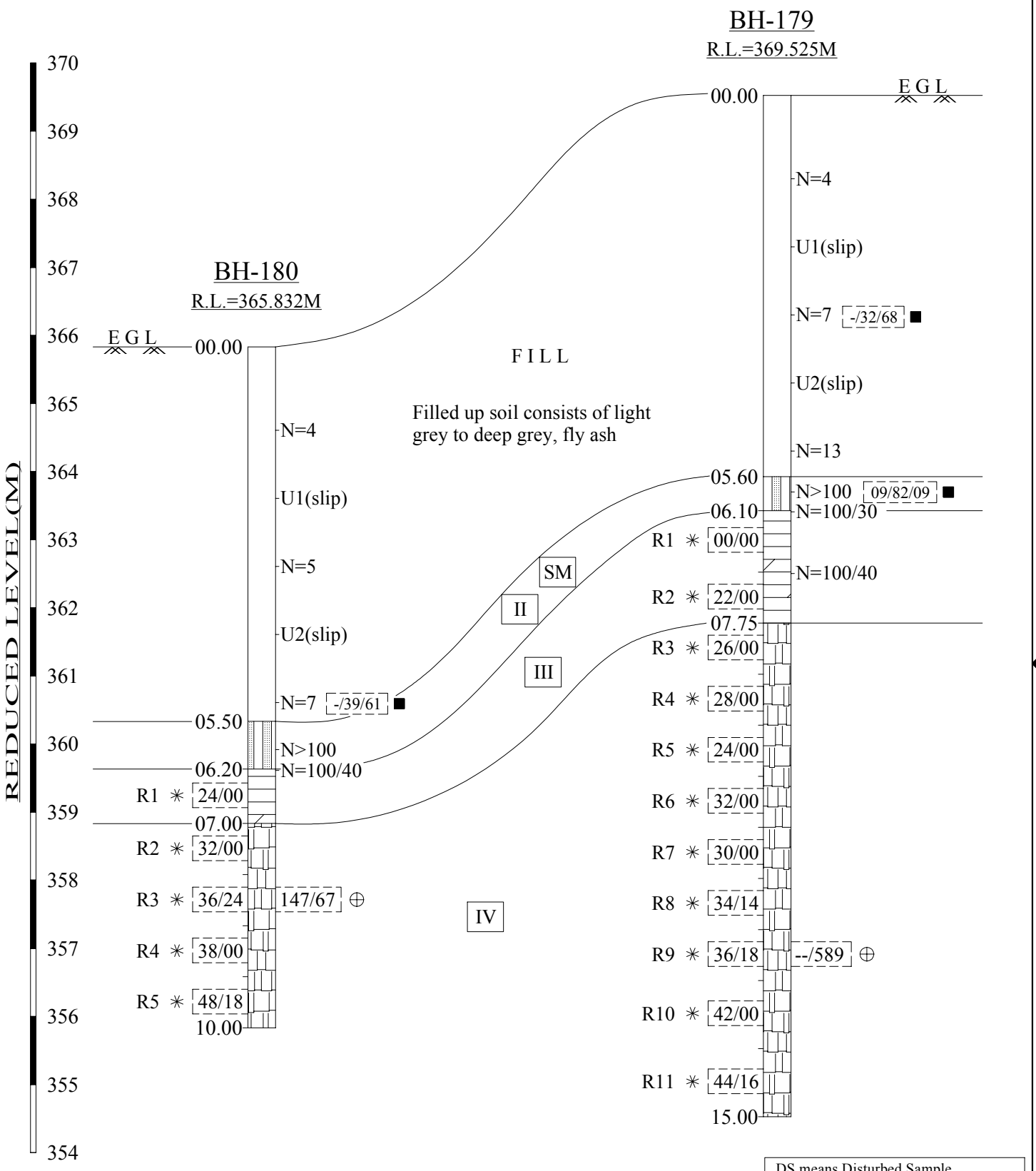
(PROPOSED PLANT BOUNDARY)

FIG. 2.46 : GENERALIZED SOIL PROFILE



(PROPOSED PLANT BOUNDARY)

FIG. 2.47 : GENERALIZED SOIL PROFILE



II → Very dense, brownish grey to yellowish brown, silty sand. Obs. decomposed rock.

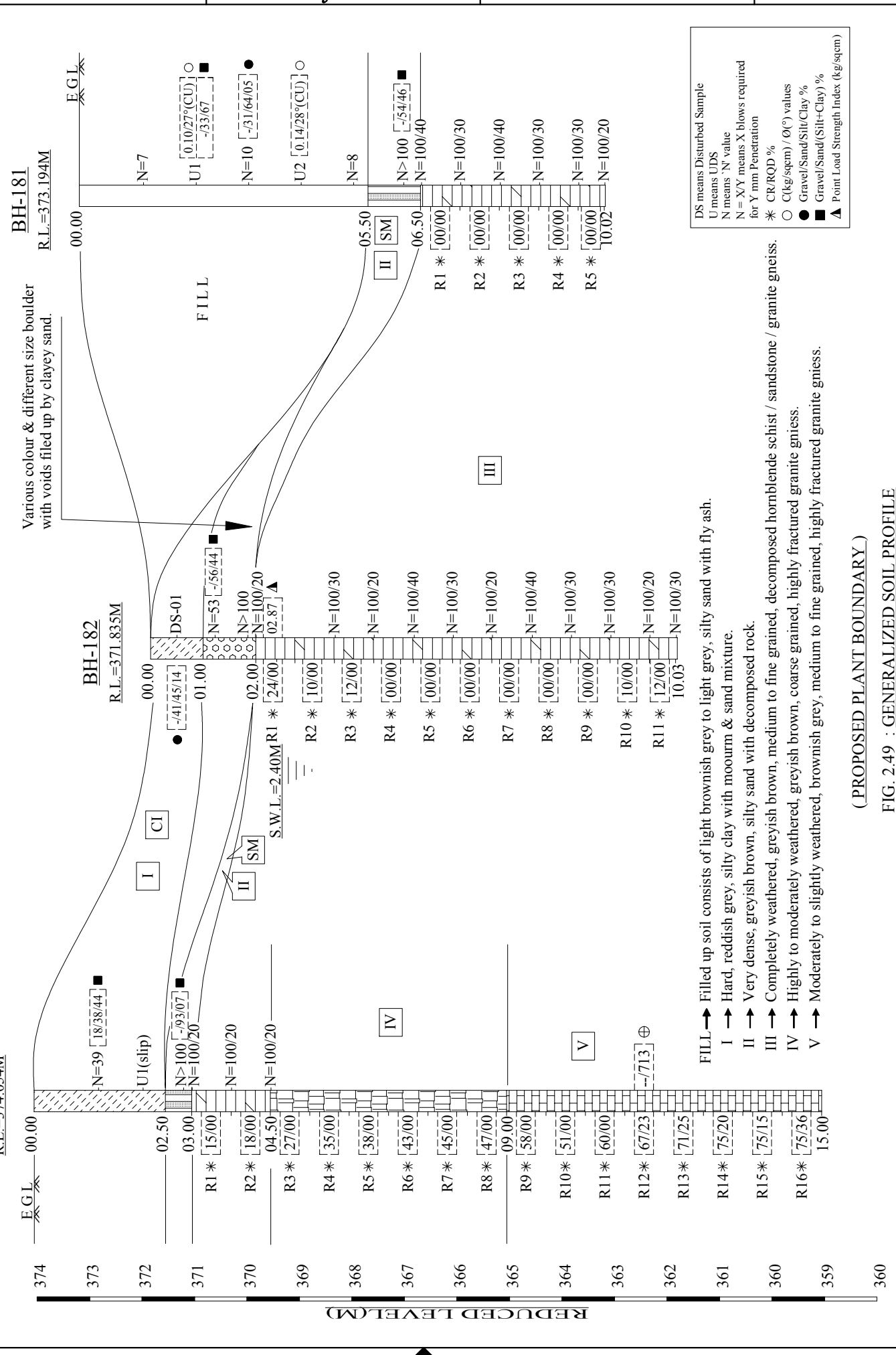
III → Completely to highly weathered, yellowish brown, fine grained, highly fractured sandstone / granite gneiss.

IV → Highly to moderately weathered, brownish grey, fractured sandstone / granite gneiss.

DS means Disturbed Sample
U means UDS
N means `N' value
N = X/Y means X blows required for Y mm Penetration
✳ CR/RQD %
○ C(kg/sqcm) / Ø(°) values
● Gravel/Sand/Silt/Clay %
■ Gravel/Sand/(Silt+Clay) %
◭ Point Load Strength Index (kg/sqcm)

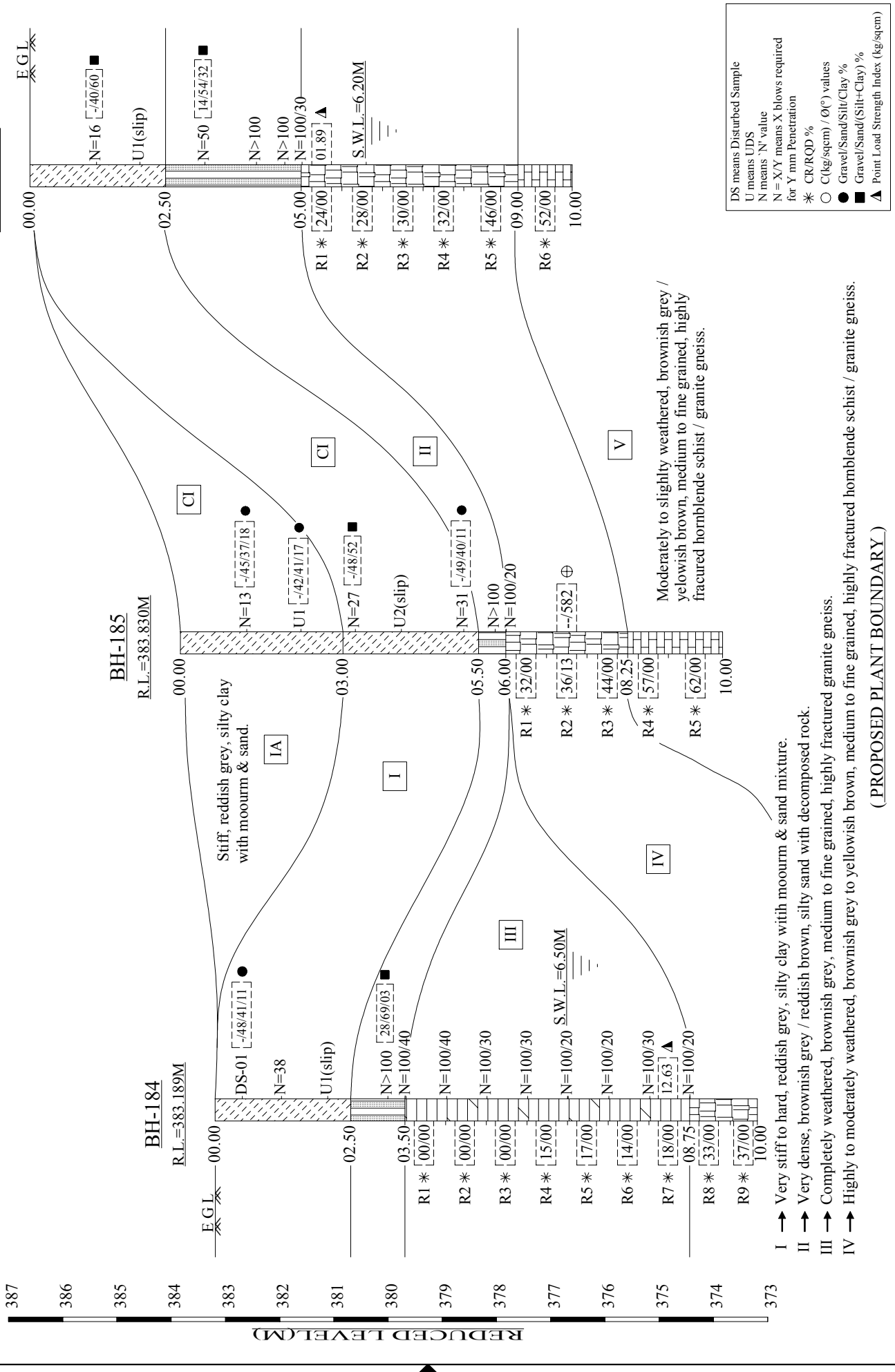
(PROPOSED PLANT BOUNDARY)

FIG. 2.48 : GENERALIZED SOIL PROFILE



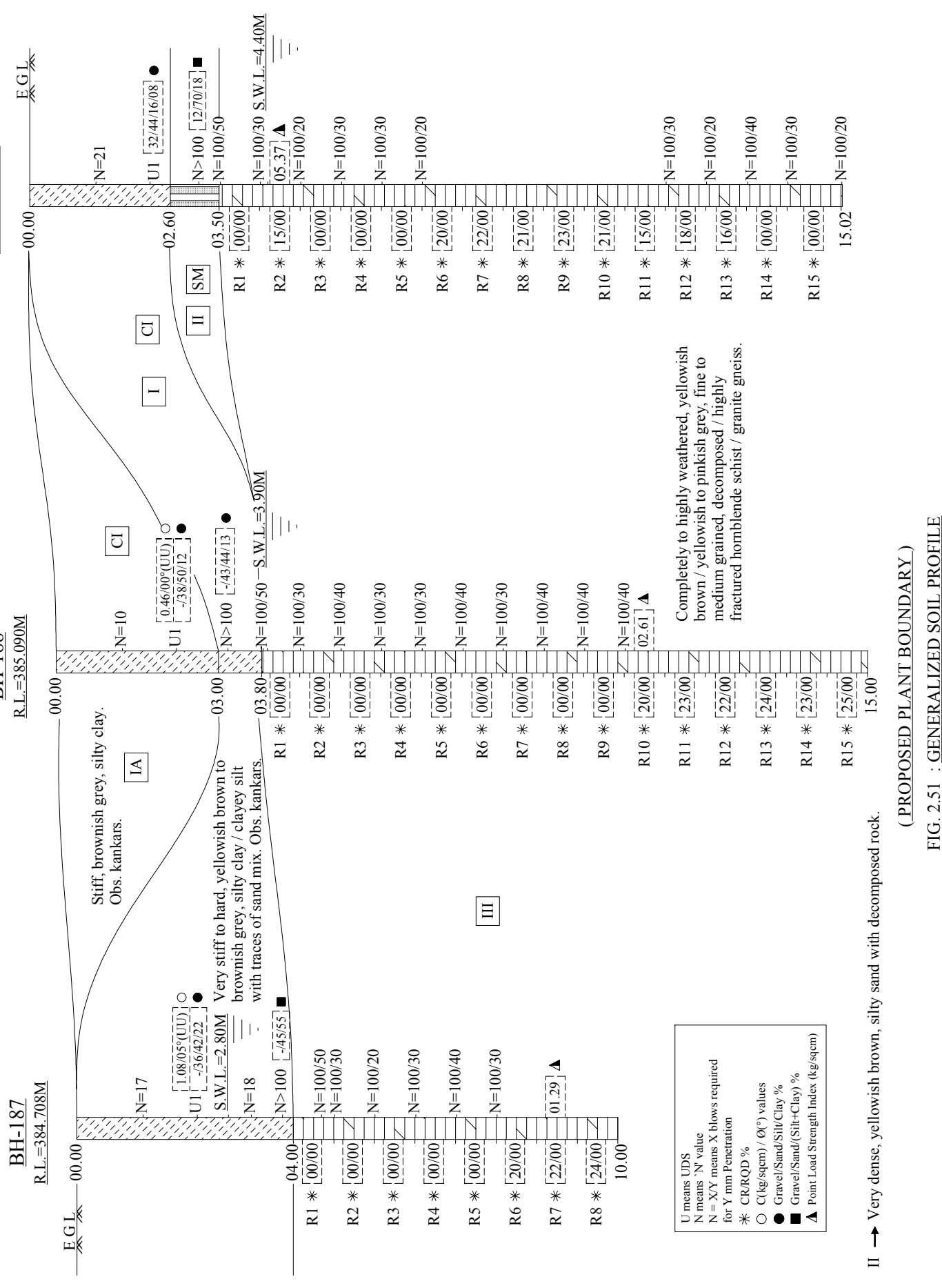
(PROPOSED PLANT BOUNDARY)

FIG. 2.49 : GENERALIZED SOIL PROFILE



(PROPOSED PLANT BOUNDARY)

FIG. 2.50 : GENERALIZED SOIL PROFILE



(PROPOSED PLANT BOUNDARY)

FIG. 2.51 : GENERALIZED SOIL PROFILE

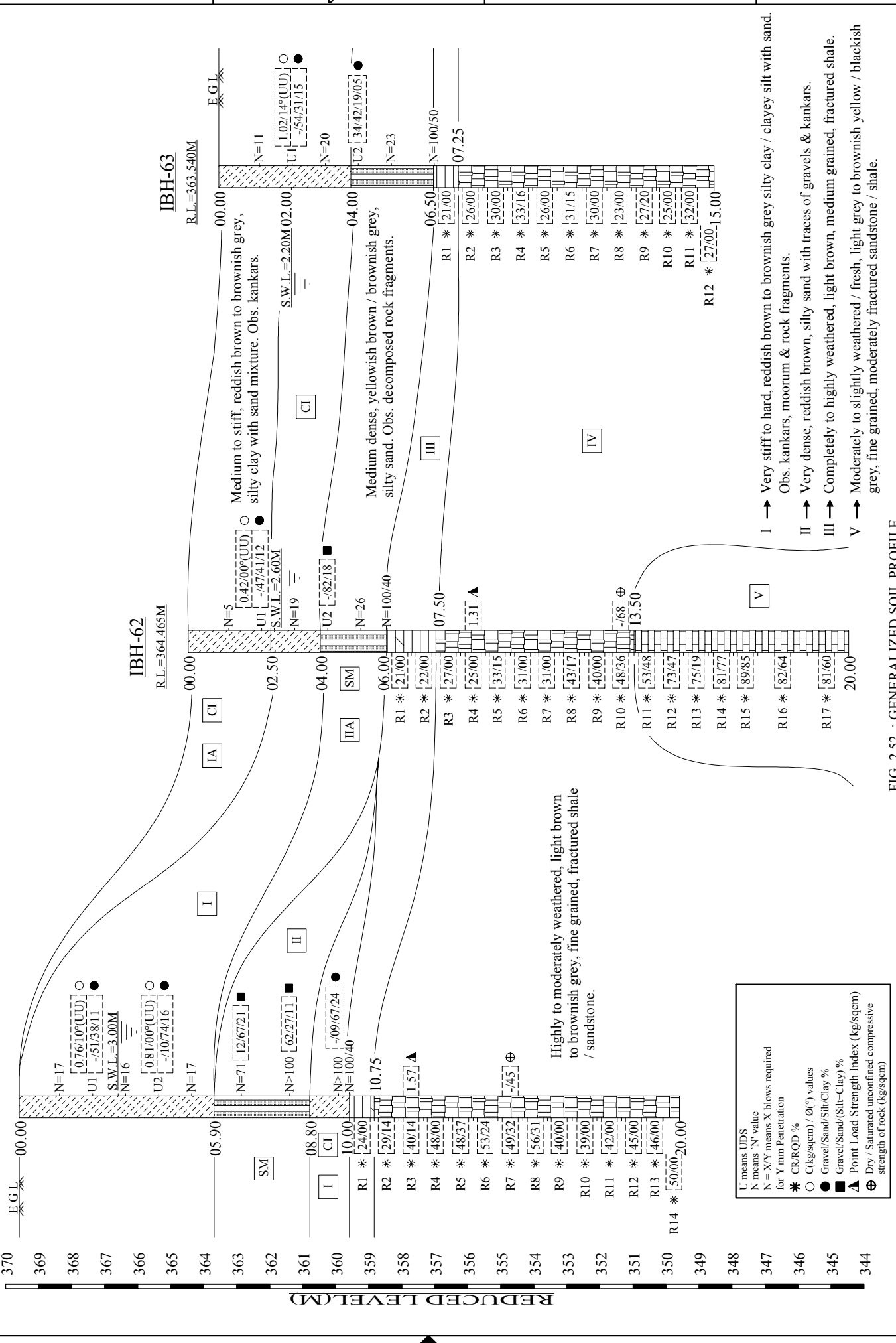


FIG. 2.52. : GENERALIZED SOIL PROFILE

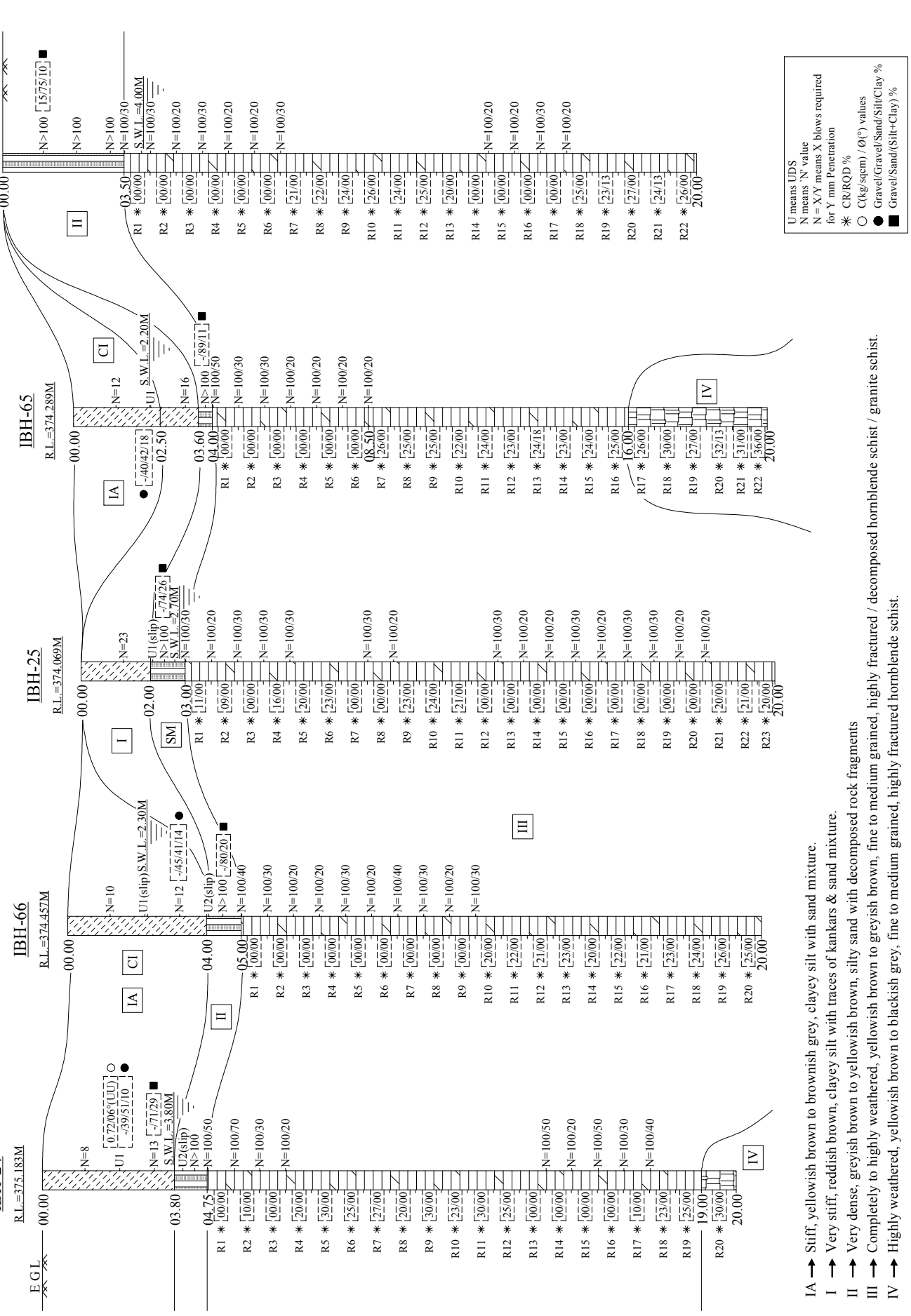


FIG. 2.53 : GENERALIZED SOIL PROFILE

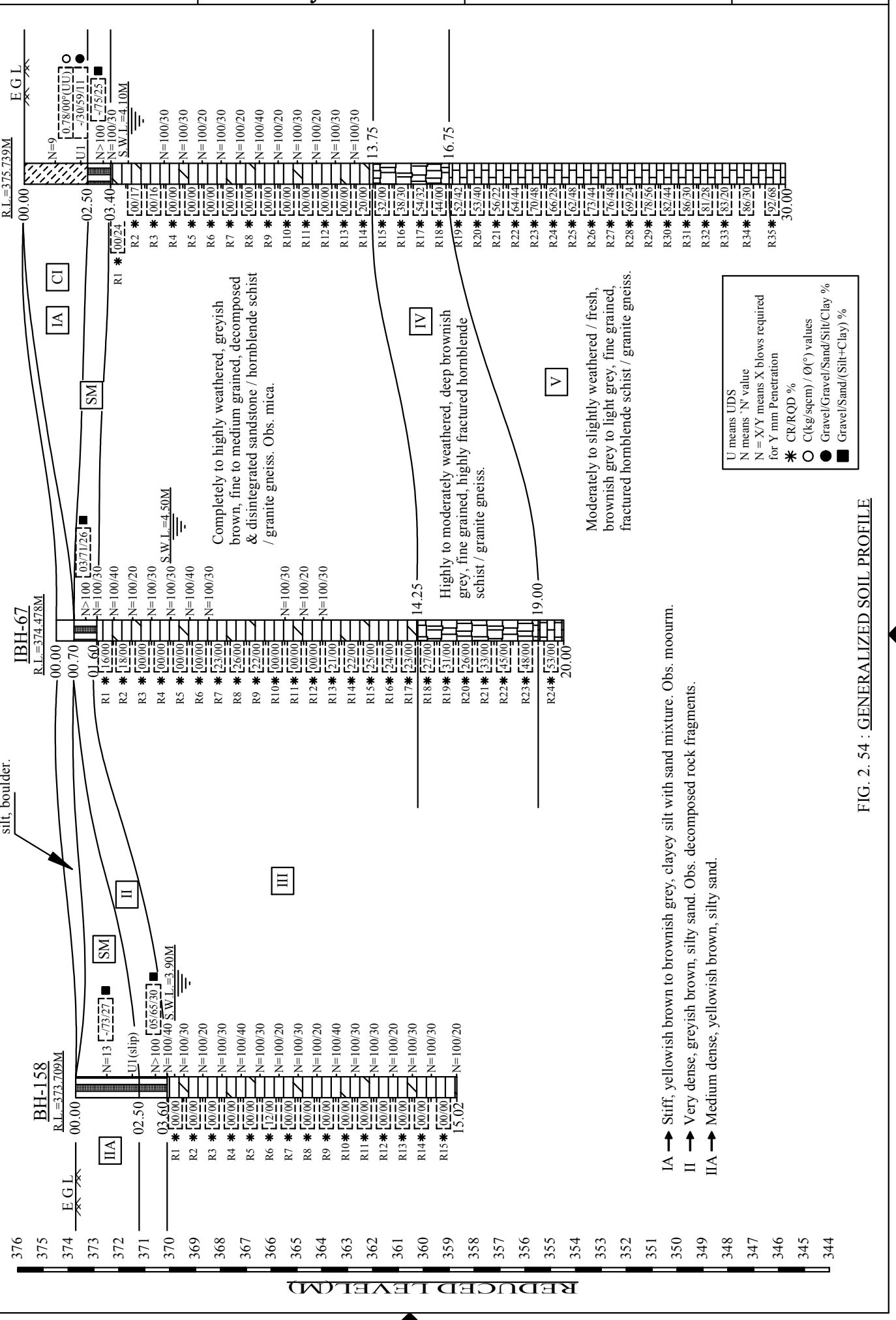


FIG. 2. 54 : GENERALIZED SOIL PROFILE

4.2.3. STRATUM - IA:

The soil in this layer is characterized by medium to stiff, brownish grey / reddish brown, silty clay / clayey silt with sand mixture. Kankar & moorum have been observed in this layer. Routine laboratory tests conducted on the "UDS", few “DS” and “SPT” samples that could be collected from this layer show the following average properties.

Bulk Density, gms/cc	2.02	Specific gravity	2.65
Dry Density, gms/cc	1.68	Void Ratio	0.561
Natural Water Content %	20	Liquid limit %	38
TRSH-UU:		Plastic Limit %	18
Cohesion kg/sqcm	0.57	Shrinkage Limit %	14
Friction angle °	5°	**GRAIN SIZE**	
		Gravel %	01
Unconfined cohesion, kg/sqcm	**0.62**	Sand %	35
Remoulded cohesion, kg/sqcm	**0.48**	Silt %	47
SENSITIVITY, S_t	**1.31**	Clay %	17

4.2.4. STRATUM - II:

This is sand layer and it consists of dense to very dense, brownish grey / yellowish grey / yellowish brown, silty sand with decomposed rock fragments. Kankar, mica & clay binder have been observed in this layer. The average properties of this layer obtained from routine laboratory tests on the "UDS", few “DS” and “SPT” samples collected from this layer are presented below.

Bulk Density, gms/cc	1.79	Liquid limit %	33
Dry Density, gms/cc	1.63	Plastic Limit %	17
Natural Water Content %	10	Shrinkage Limit %	14
Specific gravity	2.67	**GRAIN SIZE**	
Direct Shear		Gravel %	05
Cohesion kg/sqcm	0.11	Sand %	67
Friction angle °	36°	(Silt+Clay) %	28

4.2.5. STRATUM - IIA:

This is also sand layer and this layer consists of loose to medium dense, brownish grey, silty sand. Clay binders, traces of mica, moorum, kankar, etc. have also been observed in this layer. The average properties of this layer obtained from routine laboratory tests on the "UDS", few “DS” and “SPT” samples collected from this layer are presented below.

Bulk Density, gms/cc	1.77	Liquid limit %	32
Dry Density, gms/cc	1.58	Plastic Limit %	17
Natural Water Content %	12	Shrinkage Limit %	15
Specific gravity	2.64	**GRAIN SIZE**	
Direct Shear		Gravel %	04
Cohesion kg/sqcm	0.10	Sand %	64
Friction angle °	31°	(Silt+Clay) %	32

4.2.6. STRATUM - III:

This is a rock layer and this layer consists of completely to highly weathered, yellowish grey / brownish yellow / brownish grey, fine to medium / coarse grained, decomposed and disintegrated / highly fractured sandstone / shale / hornblende schist / hornblende gneiss / granite gneiss / carbonaceous shale with coal. The following tests were carried out on the rock samples viz.

1. Unconfined Compressive Strength determination of the rock samples as collected from the field (i.e. insitu condition).
2. Unconfined Compressive Strength determination of the rock samples after 24 hours full submergence and thereafter air drying before testing (i.e. saturated condition).

Determination of Point Load Strength Index.

The average properties of this layer as revealed from the routine laboratory test are as follows.

Bulk Density, gms/cc	2.384	UCS (dry), kg/sqcm	297
Dry Density, gms/cc	2.343	UCS (saturated), kg/sqcm	216
Water Absorption %	1.753	Point Load Strength Index, kg/sqcm	8.83
Specific Gravity	2.648	Slake Durability Index (%)	70.76
Porosity %	8.7187	Soundness (% Loss)	18.25

4.2.7. STRATUM - IV:

This rock layer consists of highly to moderately weathered, brownish grey / yellowish brown, fine to medium / coarse grained, fractured sandstone / shale / hornblende schist / quartz-biotite schist / hornblende gneiss / granite gneiss / carbonaceous shale with coal.

The average properties of this layer as revealed from the routine laboratory test are as follows.

Bulk Density, gms/cc	2.441	CS (dry), kg/sqcm	231
Dry Density, gms/cc	2.406	UCS (saturated), kg/sqcm	228
Water Absorption %	1.477	Point Load Strength Index, kg/sqcm	10.04
Specific Gravity	2.663	Slake Durability Index (%)	73.14
Porosity %	9.0348	Soundness (% Loss)	15.17

4.2.8. STRATUM - V:

This is also a rock layer and present around few boreholes, consists of moderately to slightly weathered, yellowish brown / light grey / brownish grey, fine to medium / coarse grained, fractured sandstone / shale / hornblende schist / granite gneiss / carbonaceous shale with coal.

The average properties of this layer as revealed from the routine laboratory test are as follows.

Bulk Density, gms/cc	2.405	UCS (dry), kg/sqcm	298
Dry Density, gms/cc	2.388	UCS (saturated), kg/sqcm	175
Water Absorption %	0.728	Point Load Strength Index, kg/sqcm	13.11
Specific Gravity	2.686	Slake Durability Index (%)	81.91
Porosity %	8.8099	Soundness (% Loss)	19.23

4.3. GRAPHICAL PRESENTATION:

The detailed Laboratory Test Results in tabular form are given in Volume-2. The back up sheets are also presented there as given in below:

1. ***Strength envelopes from Triaxial Tests.***
2. ***Normal Stress vs. Shear Stress from Direct Shear Tests.***
3. ***Standard Proctor Compaction Curves.***
4. ***CBR Curves.***
5. ***e-log p curves from consolidation tests.***
6. ***Grain size distribution curves for sieve and hydrometer tests.***

The consolidation test results are analysed by numerical methods and only the final output in a tabular form is given. The m_{vc} indicates the time dependent component of m_v and c_v is the co-efficient of consolidation.

5. DISCUSSION

5.01. PLATE LOAD TEST:

Thirty nos. (30). Plate Load Tests were conducted in the site (17 nos. are of routine type & the rest 13 nos. are of cyclic type) around Plant Area at specified depths using 450mm or 600mm square plate. Load (vs.) settlement plots is made to calculate Allowable Bearing Capacity, Young's modulus. The calculations are presented below separately.

PLT – 1:

Ultimate load achieved = 250.09 t/sqm, corresponding settlement = 15.887mm (<25mm)
Applying a FOS of 2.00, safe load becomes (250.09/2.0) = 125.04 t/sqm
So, use safe load = 125 t/sqm, corresponding settlement = 9.35 mm.

PLT – 2:

Ultimate load corresponding to 25 mm settlement = 51.10 t/sqm.
Applying a FOS of 2.50, safe load becomes (51.10/2.50) = 20.44 t/sqm
So, use safe load = 20 t/sqm, corresponding settlement = 7.10 mm (initial correction = 0.90mm).

Similar to the above the safe load and corresponding plate settlement is calculated and summarized in the table below.

Test No.	Depth (M)	Safe Load, T/M^2	Plate Settlement at Safe Load, mm
PLT-01	3.00	125	9.35
PLT-02	3.00	20	7.10
PLT-03	3.00	25	6.20
PLT-04	3.00	90	12.10
PLT-05	3.00	125	11.20
PLT-06	3.00	21	7.60
PLT-07	3.00	11	10.50
PLT-08	3.00	80	11.70
PLT-09	3.00	39	5.65
PLT-10	3.00	125	14.00
PLT-11	3.00	125	12.50
PLT-12	3.00	66	12.35
PLT-13	3.00	96	13.00
PLT-14	3.00	27	6.15
PLT-15	3.00	32	5.18
PLT-16	3.00	125	14.70
PLT-17	3.00	40	7.25
CPLT-18	3.00	28	7.00
CPLT-19	3.00	24	7.00
CPLT-20	3.00	13	5.10
CPLT-21	3.00	125	16.75
CPLT-22	3.00	25	4.70

CPLT-23	3.00	68	12.75
CPLT-24	3.00	125	10.70
CPLT-25	3.00	95	13.50
CPLT-26	3.00	92	12.15
CPLT-27	3.00	125	11.10
CPLT-28	3.00	125	11.00
CPLT-29	3.00	08	8.90
CPLT-30	3.00	42	5.75

Based on the above data, the safe bearing capacity value for different footing size is presented below.

Test Location	Depth (M)	Allowable Bearing Capacity, T/M^2				
		Foundation width = 1m	Foundation width = 2m	Foundation width = 3m	Foundation width = 4m	Foundation width = 5m
		S= 25mm	S= 25mm	S= 25mm	S= 25mm	S= 25mm
PLT-1	3.00	40	40	40	40	40
PLT-2	3.00	20	20	14	10	08
PLT-3	3.00	25	25	20	15	12
PLT-4	3.00	40	40	40	40	40
PLT-5	3.00	40	40	40	40	40
PLT-6	3.00	21	21	21	21	21
PLT-7	3.00	11	07	05	03	03
PLT-8	3.00	40	40	40	40	40
PLT-9	3.00	39	39	39	39	39
PLT-10	3.00	40	40	40	40	40
PLT-11	3.00	40	40	40	40	40
PLT-12	3.00	40	40	40	40	40
PLT-13	3.00	40	40	40	40	40
PLT-14	3.00	27	27	27	27	27
PLT-15	3.00	32	32	32	32	32
PLT-16	3.00	40	40	40	40	40
PLT-17	3.00	40	40	40	40	40
CPLT-18	3.00	28	28	20	15	12
CPLT-19	3.00	24	24	17	12	10
CPLT-20	3.00	13	13	12	09	07
CPLT-21	3.00	40	40	40	40	40
CPLT-22	3.00	25	25	25	25	25
CPLT-23	3.00	40	40	40	40	40
CPLT-24	3.00	40	40	40	40	40
CPLT-25	3.00	40	40	40	40	40
CPLT-26	3.00	40	40	40	40	40
CPLT-27	3.00	40	40	40	40	40
CPLT-28	3.00	40	40	40	40	40
CPLT-29	3.00	08	06	04	03	02
CPLT-30	3.00	40	40	40	40	40

Note :

1. Bearing Capacity for foundation in soil is restricted to 40t/sqm.
2. S = limiting settlement

Sample calculation (For PLT-2)

As per IS : 1888, In case of clayey soil, $(S_p/ S_f) = (B_p/B_f)$.

Where,

S_p = Settlement of Plate (in mm)

S_f = Settlement of Footing (in mm)

B_p = Width of Plate (in cm) = 60cm.

B_f = Width of footing (in cm) = 400cm (assumed)

Safe load = 20T.

Plate settlement, S_p = 7.10 mm

Width of plate, B_p = 60 cm

Assume width of footing, B_f = 400 cm

Substituting the values in to the above equation, footing settlement S_f = 47.33mm > 25mm. Hence for 25 mm permissible settlement, allowable bearing capacity = [(25/47.33)x20] = 10.56 t/sqm, say 10 t/sqm.

SUBGRADE MODULUS:

Subgrade Modulus is obtained from Plate Load Tests as K = P/S. Where P = Plate Load corresponding to settlement S under working load. The final results values are presented in a tabular form below.

Test No.	Depth (M)	Subgrade Modulus for Plate as per IS 9214, Kg/cm^3	Subgrade Modulus for Plate, correcting as per IS 9214, Kg/cm^3
PLT-1	3.00	11.72	6.08
PLT-2	3.00	4.08	3.61
PLT-3	3.00	4.00	3.56
PLT-4	3.00	4.40	2.44
PLT-5	3.00	10.72	5.68
PLT-6	3.00	2.08	1.16
PLT-7	3.00	1.04	0.81
PLT-8	3.00	4.32	2.40
PLT-9	3.00	8.00	4.57
PLT-10	3.00	22.40	10.33
PLT-11	3.00	8.00	4.57
PLT-12	3.00	6.40	3.92
PLT-13	3.00	9.20	5.06
PLT-14	3.00	1.92	1.07
PLT-15	3.00	4.08	2.27
PLT-16	3.00	3.08	1.71
PLT-17	3.00	4.56	2.53
CPLT-18	3.00	4.32	3.77
CPLT-19	3.00	3.52	2.75
CPLT-20	3.00	2.64	2.06
CPLT-21	3.00	8.64	4.83
CPLT-22	3.00	2.96	1.64
CPLT-23	3.00	3.20	1.78
CPLT-24	3.00	20.00	9.44
CPLT-25	3.00	5.20	3.37
CPLT-26	3.00	10.80	5.71
CPLT-27	3.00	6.08	3.77
CPLT-28	3.00	6.64	4.02
CPLT-29	3.00	0.88	0.69
CPLT-30	3.00	5.28	3.41

The Subgrade modulus value is inversely proportional to the square root of the foundation area up to a base area of 10 sqm and then remains constant. The calculated subgrade modulus values for different foundation areas are presented below.

Test No.	Depth (M)	Subgrade Modulus, (kg/cucm)			
		Foundation Area = 1 sqm	Foundation Area = 4 sqm	Foundation Area = 5 sqm	Foundation Area = 10 sqm or above
PLT-1	3.00	2.74	1.37	1.22	0.87
PLT-2	3.00	2.17	1.08	0.97	0.68
PLT-3	3.00	2.14	1.07	0.96	0.68
PLT-4	3.00	1.10	0.55	0.49	0.35
PLT-5	3.00	2.56	1.28	1.14	0.81
PLT-6	3.00	0.52	0.26	0.23	0.17
PLT-7	3.00	0.49	0.24	0.22	0.15
PLT-8	3.00	1.08	0.54	0.48	0.34
PLT-9	3.00	2.06	1.03	0.92	0.65
PLT-10	3.00	4.65	2.32	2.08	1.47
PLT-11	3.00	2.06	1.03	0.92	0.65
PLT-12	3.00	1.76	0.88	0.79	0.56
PLT-13	3.00	2.28	1.14	1.02	0.72
PLT-14	3.00	0.48	0.24	0.22	0.15
PLT-15	3.00	1.02	0.51	0.46	0.32
PLT-16	3.00	0.77	0.38	0.34	0.24
PLT-17	3.00	1.14	0.57	0.51	0.36
CPLT-18	3.00	2.26	1.13	1.01	0.72
CPLT-19	3.00	1.65	0.83	0.74	0.52
CPLT-20	3.00	1.24	0.62	0.55	0.39
CPLT-21	3.00	2.17	1.09	0.97	0.69
CPLT-22	3.00	0.74	0.37	0.33	0.23
CPLT-23	3.00	0.80	0.40	0.36	0.25
CPLT-24	3.00	4.25	2.12	1.90	1.34
CPLT-25	3.00	1.52	0.76	0.68	0.48
CPLT-26	3.00	2.57	1.28	1.15	0.81
CPLT-27	3.00	1.70	0.85	0.76	0.54
CPLT-28	3.00	1.81	0.90	0.81	0.57
CPLT-29	3.00	0.41	0.21	0.19	0.13
CPLT-30	3.00	1.53	0.77	0.69	0.49

Sample Calculation of Subgrade Modulus for foundation area 4 Sq.m for PLT-02

For Plate

Safe Load, corresponding to 1.25mm settlement = 5.10 t/sqm

Subgrade Modulus for Plate, K = P/S = 5.10/1.25 = 4.08 Kg/cm^3

Since the test was conducted on 600mm square plate (i.e. smaller than 75cm dia,), corrected Subgrade Modulus as per Clause 5.1.1 & Fig.3 of IS:9214 = 4.08 / 1.28 = 3.19 Kg/cm^3

Again applying correction for plate bending, as per Clause 5.1.3 & Fig.5 of IS:9214, corrected Subgrade Modulus = 3.61 Kg/cm^3

For Foundation

Corrected Subgrade Modulus of plate = 3.61 Kg/cm^3

Area of plate = 60x 60 sq.cm = 0.60 x 0.60 sq.m

Area of footing = 4 sq.m

Subgrade Modulus of foundation = 3.61 x $\sqrt{(0.6x0.6)/4}$ Kg/cm^3 = 1.08 Kg/cm^3

ELASTIC COMPRESSION:

For Cyclic Plate Load Tests, after application of each load increment and full stabilisation of plate settlement, the applied load was reduced to zero and the settlement records were noted till full stabilisation. Thereafter, the next load increment was applied.

The elastic rebounds at these load intensities are calculated from the field data and are graphically presented in graph (Ref. fig. no. 3.31 – 3.43). The coefficient of elastic uniform compression, C_u is obtained as $C_u = P / S_e$ (kg/cucm).

CPLT- 18:

From the load vs elastic rebound plot, the slope of the trend line = C_u = (10-5)/(1.15-0.58) = 8.77 kg/cucm

Now, for a foundation size of 10 sqm (3m x 3.33m, say), the corresponding value will be,

C_{u10sqm} = 8.77 x $\sqrt{[(0.600 \times 0.600) / 10]}$ = 1.66 kg/cucm

Test No.	Depth (M)	C_u (kg/cucm)	$C_{u\ (10sqm\ fdn.size)}$ (kg/cucm)
CPLT-18	3.00	8.77	1.66
CPLT-19	3.00	22.73	4.31
CPLT-20	3.00	12.50	2.37
CPLT-21	3.00	13.70	1.95
CPLT-22	3.00	11.49	1.64
CPLT-23	3.00	17.86	2.54
CPLT-24	3.00	80.00	11.38
CPLT-25	3.00	23.53	3.35
CPLT-26	3.00	66.67	9.49
CPLT-27	3.00	30.77	4.38
CPLT-28	3.00	33.33	4.74
CPLT-29	3.00	4.76	0.90
CPLT-30	3.00	39.22	5.58

5.02. CHOICE OF FOUNDATION AND FOUNDING LEVEL:

Considering the nature of the subsoil and the type of structures to be constructed at the present site, it is suggested to go for open foundation. Such foundation may be placed at a depth of 1.00m or more below FGL / NGL. The determination of bearing capacity is presented below.

5.03. DETERMINATION OF BEARING CAPACITY (Around Unit-1):

Let us place the foundation at 9.0m below FGL i.e. 5.9m below EGL (where, FGL = 375 M).

Founding level falls inside stratum -III.

This layer consists of complete weathered, decomposed and disintegrated rock.

Considering this as granular soil, use lowest probable value of Φ = 35° for bearing capacity calculation using C-Φ method.

CALCULATION OF NET SAFE BEARING CAPACITY:

The Net Ultimate Bearing Capacity is given as:

$$q_{nu} = C.N_c.S_c.D_c + q.N_q.S_q.D_q + 0.5\gamma.B.N_\gamma.S_\gamma.D_\gamma - q$$

Where,

N_c, N_q and N_γ are bearing capacity factors,
S_c, S_q and S_γ are shape factors,
D_c, D_q and D_γ are depth factors,

And

C = Cohesion
q = Overburden pressure,
B = Width of foundation,
γ = Effective density below foundation.

For 50m Dia. Circular Footing Placed at 9.00m below FGL

Cohesion, C = 0.00 t/sqm
Using ϕ = 35 degree, the bearing capacity factors are:

N_c = 46.12
N_q = 33.30
N_γ = 48.03

Use,

Depth of Foundation = D_f = 5.9 M below EGL (i.e. 9m below FGL)
Diameter of Foundation = B = 50 M

Overburden Pressure = q =5.900 (Depth) x 0.90 (Submerged density) = 5.31 t/sqm (assuming the ground water table is flushing with the ground level)

The Shape factors are [IS:6403 - 1981]

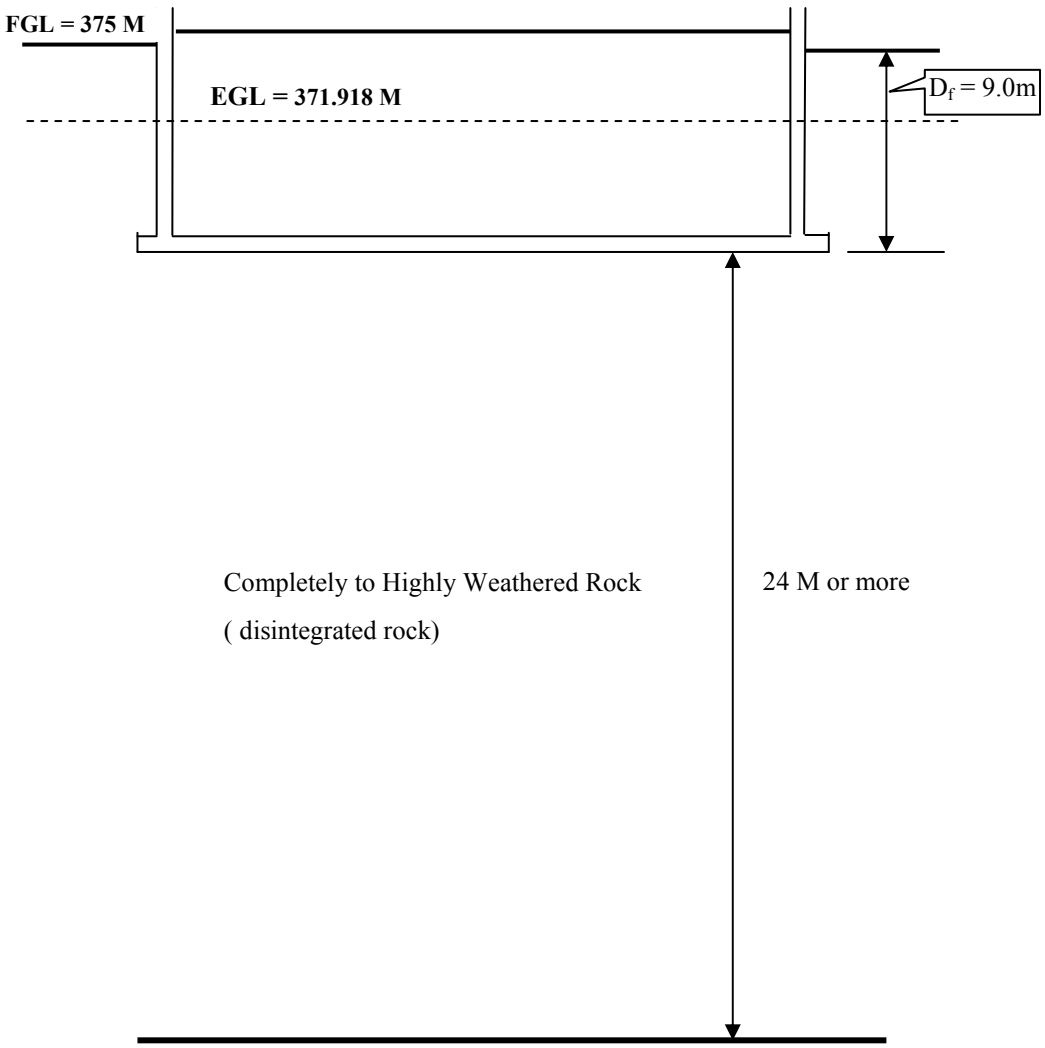
S_c = 1.30 S_q = 1.20 S_γ = 0.60

The Depth factors are [IS:6403 - 1981]

D_c = 1.05 D_q = 1.02 D_γ = 1.02

Computed Net Ultimate Bearing Capacity = 874.75 t/sqm

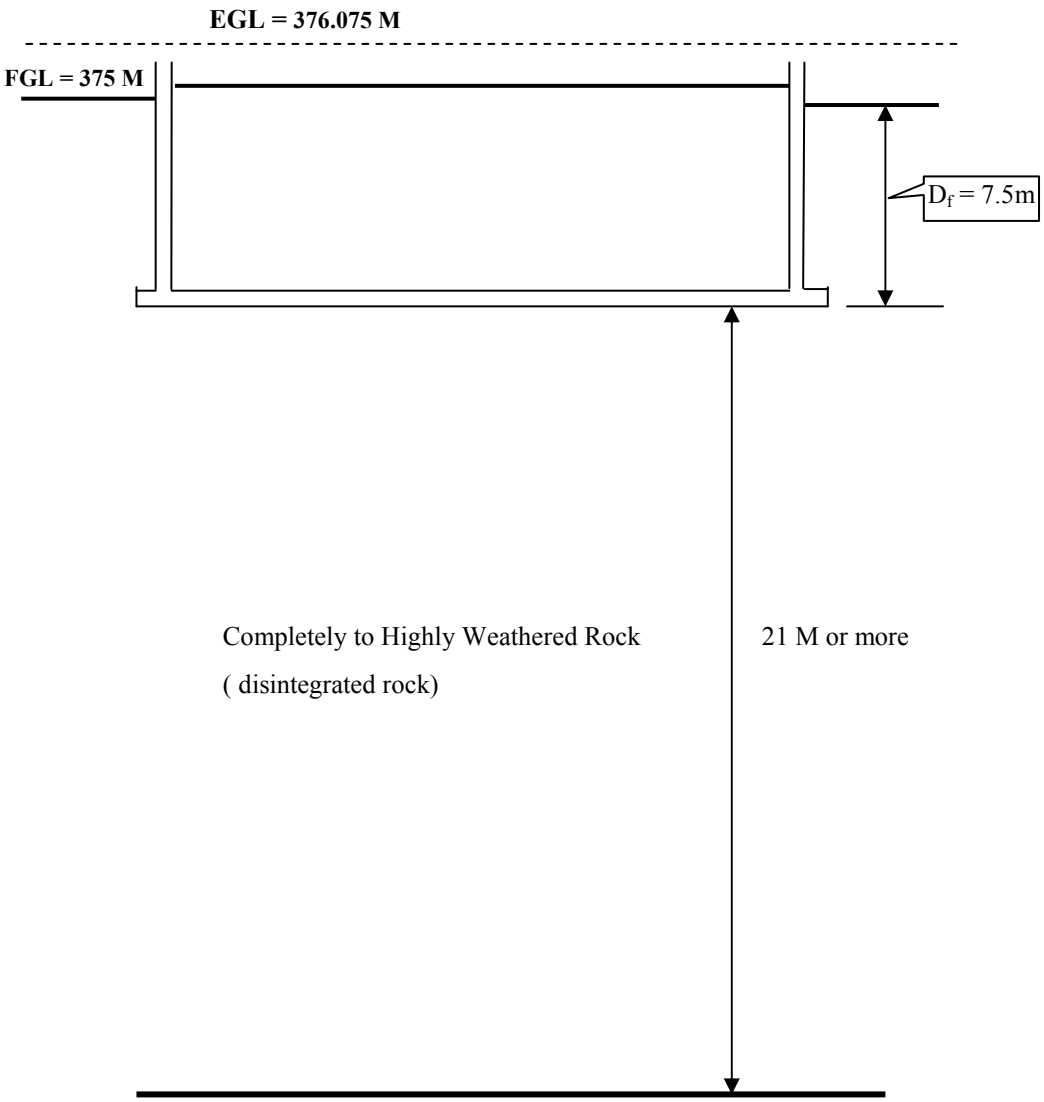
Using a factor of safety of 2.5, Net Safe Bearing Capacity = 349.90 t/sqm



RAFT FOUNDATION DESIGN MODEL FOR CHIMNEY UNIT 1

Using design layer stratification around BH111

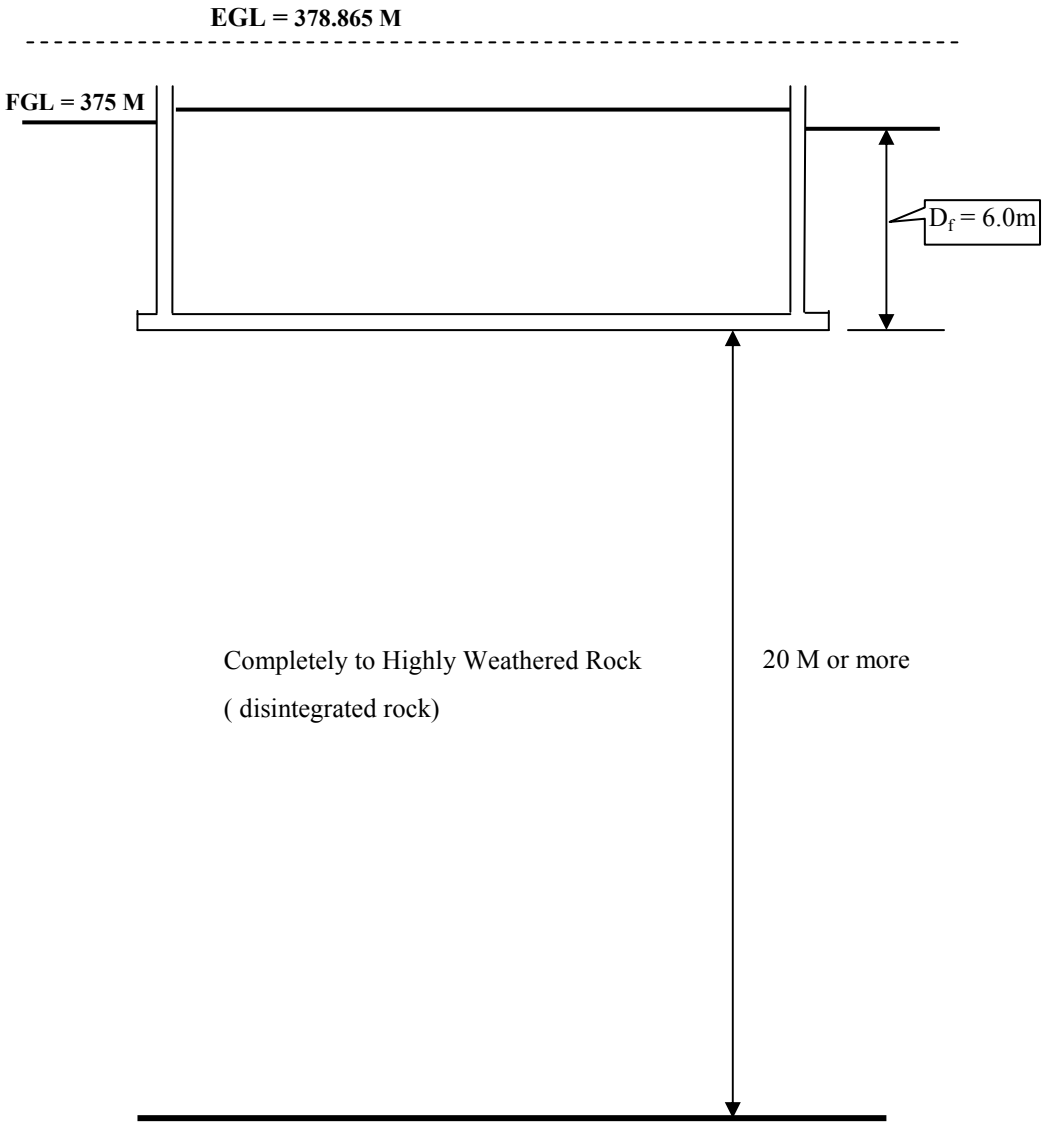
(Not to Scale)



RAFT FOUNDATION DESIGN MODEL FOR CHIMNEY UNIT 2

Using design layer stratification around BH101

(Not to Scale)



RAFT FOUNDATION DESIGN MODEL FOR CHIMNEY UNIT 3

Using design layer stratification around BH92

(Not to Scale)

BEARING CAPACITY BASED ON RMR METHOD:

Based on the geological observation so found from rock core samples the bearing capacity is calculated as follows:

For Layer III (9.0m depth below FGL) around Chimney Unit-1:

Calculated RMR = 22 as per IS: 13365(Part1)-1998, Annex B

a) The average value of point load in layer III is taken as 1.62 kg/sqcm, converted to UCS value of 35.64 kg/sqcm. Corresponding rating = 1
b) RQD value, a minimum of 10% is considered as per codal provision (IS 13365, Part 1), corresponding rating = 03
c) Spacing of discontinuity taken as very close. corresponding rating = 05
d) Condition of discontinuity [Refer "Support of Underground Excavations in Hard Rock" by E. Hoek, P.K. Kaiser & W.F. Bawden, Table 4.4: Rock Mass Rating System (After Bieniawski, 1989) attached at the end of this report]
   I. Discontinuity length (persistence) taken as 1-3m, corresponding rating = 04
   II. Roughness considered as slightly rough, corresponding rating = 03
   III. Weathering condition considered as highly weathered, corresponding rating = 01
e) Ground water condition taken as Wet. corresponding rating = 07
f) Dip Angle Joint Orientation taken as favourable (based on geological formation), corresponding rating = (-)2

So, RMR = 01+03+05+04+03+01+07+(-)2 = 22

So, from Table-3 of IS: 12070 (Amendment 1, Nov. 2008) q_{ns} = 52.58 t/sqm (by interpolation) for 12mm settlement.

Hence, use a net allowable bearing capacity of 50 t/sqm for depth of foundation of 9.0m below FGL around Chimney Unit-1.

For Layer III (7.5m depth below FGL) around Chimney Unit-2:

Calculated RMR = 22 as per IS: 13365(Part1)-1998, Annex B

a) The average value of point load in layer III is taken as 1.62 kg/sqcm, converted to UCS value of 35.64 kg/sqcm. Corresponding rating = 1
b) RQD value, a minimum of 10% is considered as per codal provision (IS 13365, Part 1), corresponding rating = 03
c) Spacing of discontinuity taken as very close. corresponding rating = 05
d) Condition of discontinuity :
   I. Discontinuity length (persistence) taken as 1-3m, corresponding rating = 04
   II. Roughness considered as slightly rough, corresponding rating = 03
   III. Weathering condition considered as highly weathered, corresponding rating = 01
e) Ground water condition taken as Wet. corresponding rating = 07
f) Dip Angle Joint Orientation taken as favourable (based on geological formation), corresponding rating = (-)2

So, RMR = 01+03+05+04+03+01+07+(-)2 = 22

So, from Table-3 of IS: 12070 (Amendment 1, Nov. 2008) q_{ns} = 52.58 t/sqm (by interpolation) for 12mm settlement.

Hence, use a net allowable bearing capacity of 50 t/sqm for depth of foundation of 7.5m below FGL around Chimney Unit-2.

For Layer III (6.0m depth below FGL) around Chimney Unit-3:

Calculated RMR = 22 as per IS: 13365(Part1)-1998, Annex B

a) The average value of point load in layer III is taken as 1.62 kg/sqcm, converted to UCS value of 35.64 kg/sqcm. Corresponding rating = 1
b) RQD value, a minimum of 10% is considered as per codal provision (IS 13365, Part 1), corresponding rating = 03
c) Spacing of discontinuity taken as very close. corresponding rating = 05
d) Condition of discontinuity :
   I. Discontinuity length (persistence) taken as 1-3m, corresponding rating = 04
   II. Roughness considered as slightly rough, corresponding rating = 03
   III. Weathering condition considered as highly weathered, corresponding rating = 01
e) Ground water condition taken as Wet. corresponding rating = 07
f) Dip Angle Joint Orientation taken as favourable (based on geological formation), corresponding rating = (-)2

So, RMR = 01+03+05+04+03+01+07+(-)2 = 22

So, from Table-3 of IS: 12070 (Amendment 1, Nov. 2008) q_{ns} = 52.58 t/sqm (by interpolation) for 12mm settlement.

Hence, use a net allowable bearing capacity of 50 t/sqm for depth of foundation of 6.0m below FGL around Chimney Unit-3.

Based on the above, the structurewise recommended bearing capacity values have been presented in sec. 6.

5.04. SWELLING CHARACTERISTICS:

The swelling pressure and Free Swell Index tests were performed on a few samples and the test results are presented at the end of Volume-2 (Part II). The average swelling pressure and Free Swell Index as found from the tests are 0.14kg/sqcm and 11.27% respectively. It is seen that the soil has low to medium swelling characteristics. So, no problem with respect to the swelling of the subsoil is anticipated in general.

5.05. FIELD PERMEABILITY TEST RESULTS:

Field permeability tests were conducted at five different depths in each of 22 nos. bore holes by falling head or single packer or double packer method and the test results are presented in volume-2 (Part I). Sample calculations are also enclosed at the end of Volume-2 (Part IV).

5.06. STANDARD PROCTOR COMPACTION & CBR TEST:

Standard Proctor Compaction tests were carried out in the laboratory to determine the Optimum Moisture Content (OMC) and Maximum Dry Density (MDD). Thereafter, CBR (4 days soaked) tests were carried out on the samples prepared at 95% of MDD. The test results and graphs are presented in Volume 2 (Part II & III respectively).

5.07. CHEMICAL TESTS:

Chemical tests were performed on few soil and water samples for determining the pH value, Sulphate, Chloride content etc. The results are presented in Volume-2 (Part II). It is seen that the values are on a safer side and so no special cement will be required for foundation concrete. **Either Ordinary Portland cement or Portland slag cement or Portland Pozzolana cement can be used for the purpose.**

5.08. SUITABILITY OF EXISTING SOIL FOR FILLING AND BACK-FILLING:

The subsoil at the site is inorganic in nature & consists of silty clay with sand / clayey silty sand having low to medium swelling properties. So, the soil can be used for filling and backfilling purposes with necessary compaction as required.

5.09. SUITABILITY OF SOIL FOR CONSTRUCTION OF ROADS & PAVEMENT:

The subsoil at the site is inorganic in nature & consists of silty clay with sand / clayey silty sand having low to medium swelling properties. Thus the soil can be used for the construction of roads and pavement.

In the laboratory, standard proctor compaction tests were performed, using samples collected at a depth varying from 1.00-4.00m below ground level. The MDD ranges between 1.296 gm/cc to 1.986 gm/cc.

Laboratory CBR tests were performed on remoulded soil samples (compacted at 95% of MDD) under soaked condition (4days soaking). The CBR values are in the range of 4% to 7% (with few stray values varing from 17% to 25%) for soaked condition.

Considering the above, CBR value of 4% may be used for pavement subgrade design.

5.10. EARTH PRESSURE CO-EFFICIENT:

The co-efficient of earth pressure at rest is calculated based on the following formula and using the Cross Hole Test results. Co-efficient of Earth Pressure at Rest, $K_0 = \mu / (1-\mu)$

For design purpose, the following average values can be used.

Depth (M)	Design Average K_0 value
0.00 – 5.00	0.39
5.00 – 10.00	0.32
10.00 – 15.00	0.24
Below 15m	0.19

The Co-efficient of earth pressure at Active and Passive State are given below in a tabular form.

Layer	K_a	K_p
Layer – I	0.32	3.12
Layer – IA	0.33	3.00
Layer – II	0.29	3.39
Layer – IIA	0.35	2.88
Layer – III & IV	0.27	3.69
Layer - V	0.25	4.02

6. SUMMARY & CONCLUSIONS

Based on the field tests and the foregoing discussion the following are summarised.

1. The subsoil is characterised by silty clay / silty sand layer with varying consistency. After the soil layer, weathered rock layer is struck and that continues upto the terminating depth of all the boreholes. However, at few locations filed up soil / fly ash has been observed at top.

2. Thirty nos. (30) Plate Load Tests were conducted around plant area (17 nos. are of routine type & rest 13 nos. are of cyclic type). The safe load & corresponding plate settlement, subgrade modulus & settlement for foundation and the dynamic properties using the elastic rebound as we obtain from CPLT-17 to 30 have been discussed in the section 5.1.

3. Considering the subsoil condition and the proposed structure to be constructed at the present site, it is suggested to go for open foundation.

4. Considering the subsoil condition and the proposed structure to be constructed at the present site, it is suggested to go for open foundation. The recommended bearing capacity values at different depth of foundation are presented in the table below.

Foundation Location	Df below FGL (M)	Width of Foundation (m)	NSBC (t/sqm)	NABC (t/sqm)				Remarks
				S = 12mm	S = 25mm	S = 40mm	S = 75mm	
Switch Yard (BH-01 to 05 & 07 to 09)	1.00 - 5.50	Filled up soil						FGL = (+) 372M
	7.00	Upto 6	19	--	--	8	--	
		≥ 6	18	--	--	--	10	
	8.00	Upto 6	20	--	--	12	--	
		≥ 6	18	--	--	--	15	
	9.00	Upto 6	20	--	9	14	--	
		≥ 6	19	--	--	--	19	
	13.50	Upto 6	157	30	--	--	--	
		≥ 6	159	35	--	--	--	
Tower/Gantries Between Switch Yard and ACC (BH-06, 10)	0.85	Filled up soil						FGL = (+) 372M
	2.00	Upto 6	29	--	--	8	--	
		≥ 6	45	--	--	--	10	
	3.00	Upto 6	43	--	--	12	--	
		≥ 6	56	--	--	--	15	
	4.50	Upto 6	91	30	--	--	--	
		≥ 6	102	35	--	--	--	
	5.00	Upto 6	100	40	--	--	--	
		≥ 6	110	40	--	--	--	
Tower/Gantries Between Switch Yard and ACC (BH-194)	1.00 - 3.50	Filled up soil						FGL = (+) 372M
	4.50	Upto 6	15	--	--	7	--	
		≥ 6	14	--	--	--	10	
	5.50	Upto 6	16	--	--	8	--	
		≥ 6	15	--	--	--	15	
	6.50	Upto 6	16	--	6	10	--	
		≥ 6	15	--	--	--	19	
	9.50	Upto 6	40	--	24	30	--	
		≥ 6	38	--	--	--	30	

Foundation Location	Df below FGL (M)	Width of Foundation (m)	NSBC (t/sqm)	NABC (t/sqm)				Remarks
				S = 12mm	S = 25mm	S = 40mm	S = 75mm	
Tower/Gantries Between Switch Yard and ACC (BH-191 & 193)	1.00 - 4.80	Filled up soil						FGL = (+) 375M
	6.00	Upto 6	40	--	--	8	--	
		≥ 6	38	--	--	--	10	
	7.00	Upto 6	141	30	--	--	--	
		≥ 6	144	35	--	--	--	
	7.50	Upto 6	151	40	--	--	--	
		≥ 6	153	40	--	--	--	
Tower/Gantries Between Switch Yard and ACC (BH-192)	1.00 - 5.00	Filled up soil						FGL = (+) 375M
	6.00	Upto 6	12	--	--	8	--	
		≥ 6	12	--	--	--	10	
	7.00	Upto 6	16	--	--	12	--	
		≥ 6	16	--	--	--	15	
	8.00	Upto 6	25	--	15	18	--	
		≥ 6	23	--	--	--	20	
	10.00	Upto 6	29	--	16	22	--	
		≥ 6	31	--	--	--	30	
Transformer Yard & ACC Area #1 (BH-11, 12, 14 & 25)	1.00 - 3.60	Filled up soil						FGL = (+) 375M
	5.00	Upto 6	30	--	--	8	--	
		≥ 6	28	--	--	--	10	
	6.00	Upto 6	54	--	--	12	--	
		≥ 6	50	--	--	--	15	
	7.00	Upto 6	141	30	--	--	--	
		≥ 6	144	35	--	--	--	
	7.50	Upto 6	151	40	--	--	--	
		≥ 6	153	40	--	--	--	
Transformer Yard & ACC Area #1 (BH-13)	Upto 1.30	Filled up soil						FGL = (+) 375M
	2.50	Upto 6	16	--	--	7	--	
		≥ 6	15	--	--	--	10	
	3.50	Upto 6	16	--	--	8	--	
		≥ 6	15	--	--	--	13	
	4.50	Upto 6	17	--	6	9	--	
		≥ 6	16	--	--	--	14	
	8.00	Upto 6	37	--	16	26	--	
		≥ 6	34	--	--	--	30	
Transformer Yard & ACC Area #1 (BH-26 & 27)	1.00	Upto 6	23	22	--	--	--	FGL = (+) 375M
		≥ 6	56	40	--	--	--	
	2.00	Upto 6	45	40	--	--	--	
		≥ 6	71	45	--	--	--	
Transformer Yard & ACC Area #1 (BH-28)	1.00	Upto 6	28	--	--	8	--	FGL = (+) 375M
		≥ 6	27	--	--	--	10	
	2.00	Upto 6	40	--	--	12	--	
		≥ 6	64	--	--	--	15	
	3.50	Upto 6	70	30	--	--	--	
		≥ 6	86	35	--	--	--	
	4.00	Upto 6	81	40	--	--	--	
		≥ 6	94	40	--	--	--	
Transformer Yard & ACC Area #2 (BH-15)	1.00 - 4.20	Filled up soil						FGL = (+) 375M
	5.50	Upto 6	26	--	--	8	--	
		≥ 6	25	--	--	--	10	
	6.50	Upto 6	27	--	--	12	--	
		≥ 6	25	--	--	--	15	
	7.50	Upto 6	28	--	15	18	--	
		≥ 6	26	--	--	--	20	

Foundation Location	Df below FGL (M)	Width of Foundation (m)	NSBC (t/sqm)	NABC (t/sqm)				Remarks
				S = 12mm	S = 25mm	S = 40mm	S = 75mm	
Transformer Yard & ACC Area #2 (BH-16)	1.50	Upto 6	23	--	--	8	--	FGL = (+) 375M
		≥ 6	23	--	--	--	10	
	2.50	Upto 6	24	--	--	12	--	
		≥ 6	23	--	--	--	15	
	3.50	Upto 6	25	--	15	18	--	
		≥ 6	24	--	--	--	20	
Transformer Yard & ACC Area #2 (BH-22 to 24)	1.00	Upto 6	31	--	--	8	--	FGL = (+) 375M
		≥ 6	31	--	--	--	10	
	2.00	Upto 6	40	30	--	--	--	
		≥ 6	64	35	--	--	--	
	2.50	Upto 6	58	40	--	--	--	
		≥ 6	81	40	--	--	--	
Transformer Yard & ACC Area #3 (BH-17 to 19)	1.00 - 2.70	Filled up soil						FGL = (+) 375M
	4.00	Upto 6	36	--	--	8	--	
		≥ 6	34	--	--	--	10	
	5.00	Upto 6	37	--	--	12	--	
		≥ 6	35	--	--	--	15	
	6.00	Upto 6	121	30	--	--	--	
		≥ 6	127	35	--	--	--	
	6.50	Upto 6	131	40	--	--	--	
		≥ 6	135	40	--	--	--	
Transformer Yard & ACC Area #3 (BH-20 & 21)	1.50	Upto 6	30	30	--	--	--	FGL = (+) 375M
		≥ 6	57	35	--	--	--	
	2.00	Upto 6	40	40	--	--	--	
		≥ 6	64	40	--	--	--	
DG Building (BH-29)	1.00	Upto 6	10	--	--	8	--	FGL = (+) 375M
		≥ 6	10	--	--	--	10	
	2.50	Upto 6	51	30	--	--	--	
		≥ 6	71	35	--	--	--	
Service Building and E Pit & S Pit Area (BH-30 & 190)	1.50	Upto 6	30	30	--	--	--	FGL = (+) 375M
		≥ 6	57	35	--	--	--	
	2.00	Upto 6	40	40	--	--	--	
		≥ 6	64	40	--	--	--	
Power House Area #1 (BH-31 to 38)	3.00	Upto 6	60	40	--	--	--	FGL = (+) 375M
		≥ 6	78	40	--	--	--	
	5.00	Upto 6	112	50	--	--	--	
		≥ 6	122	50	--	--	--	
Power House Area #2 (BH-39 to 45)	1.00	Upto 6	23	23	--	--	--	FGL = (+) 375M
		≥ 6	56	40	--	--	--	
	2.00	Upto 6	45	45	--	--	--	
		≥ 6	71	50	--	--	--	
	3.00	Upto 6	67	50	--	--	--	
		≥ 6	87	50	--	--	--	
Power House Area #3 (BH-46 to 55 & 63)	3.00	Upto 6	31	--	15	18	--	FGL = (+) 375M
		≥ 6	30	--	--	--	20	
	4.00	Upto 6	81	30	--	--	--	
		≥ 6	94	35	--	--	--	
	4.50	Upto 6	91	40	--	--	--	
		≥ 6	102	40	--	--	--	
	5.50	Upto 6	111	50	--	--	--	
		≥ 6	118	50	--	--	--	

Foundation Location	Df below FGL (M)	Width of Foundation (m)	NSBC (t/sqm)	NABC (t/sqm)				Remarks
				S = 12mm	S = 25mm	S = 40mm	S = 75mm	
Mill Bunker #1, #2 & #3 (BH-56, 57, 61, 65, 66 & 71)	1.00	Upto 6	23	23	--	--	--	FGL = (+) 375M
		≥ 6	56	40	--	--	--	
	2.00	Upto 6	45	45	--	--	--	
		≥ 6	71	50	--	--	--	
Boiler #1, #2 & #3 (BH-58 to 60, 62, 64, 67 to 70 & 72 to 74)	1.00	Upto 6	23	23	--	--	--	FGL = (+) 375M
		≥ 6	56	40	--	--	--	
	2.00	Upto 6	45	45	--	--	--	
		≥ 6	71	50	--	--	--	
Compressor House (BH-75)	1.50	Upto 6	30	30	--	--	--	FGL = (+) 375M
		≥ 6	57	35	--	--	--	
	2.00	Upto 6	40	40	--	--	--	
		≥ 6	64	40	--	--	--	
ESP #1 (BH-76 to 79)	Upto 1.55	Filled up soil						FGL = (+) 375M
	3.50	Upto 6	80	30	--	--	--	
		≥ 6	98	35	--	--	--	
	4.00	Upto 6	92	40	--	--	--	
		≥ 6	107	40	--	--	--	
	5.00	Upto 6	112	45	--	--	--	
		≥ 6	122	45	--	--	--	
ESP #2 & #3 (BH-80 to 87)	1.00	Upto 6	23	23	--	--	--	FGL = (+) 375M
		≥ 6	56	40	--	--	--	
	2.00	Upto 6	45	45	--	--	--	
		≥ 6	71	45	--	--	--	
ESP Control Room #2 & #3 (BH-88 & 97)	1.00	Upto 6	23	23	--	--	--	FGL = (+) 375M
		≥ 6	56	40	--	--	--	
	2.00	Upto 6	45	45	--	--	--	
		≥ 6	71	45	--	--	--	
ESP Control Room #1 (BH-108)	1.00	Upto 6	24	--	--	8	--	FGL = (+) 375M
		≥ 6	23	--	--	--	10	
	2.50	Upto 6	51	30	--	--	--	
		≥ 6	71	35	--	--	--	
	3.00	Upto 6	67	40	--	--	--	
		≥ 6	87	40	--	--	--	
ID Fan #3 (BH-89 & 95)	1.00	Upto 6	23	23	--	--	--	FGL = (+) 375M
		≥ 6	56	40	--	--	--	
	2.00	Upto 6	45	45	--	--	--	
		≥ 6	71	50	--	--	--	
ID Fan #2 (BH-99 & 104)	1.00	Upto 6	12	--	--	8	--	FGL = (+) 375M
		3 - 6	28	--	--	--	10	
	2.50	Upto 6	51	30	--	--	--	
		≥ 6	71	35	--	--	--	
	3.00	Upto 6	60	40	--	--	--	
		≥ 6	78	40	--	--	--	
ID Fan #1 (BH-109 & 116)	1.00	Upto 6	21	--	--	8	--	FGL = (+) 375M
		≥ 6	35	--	--	--	10	
	2.00	Upto 6	40	--	--	12	--	
		≥ 6	64	--	--	--	15	
	3.00	Upto 6	60	--	15	18	--	
		≥ 6	78	--	--	--	20	
	3.50	Upto 6	80	30	--	--	--	
		≥ 6	98	35	--	--	--	

Foundation Location	Df below FGL (M)	Width of Foundation (m)	NSBC (t/sqm)	NABC (t/sqm)				Remarks
				S = 12mm	S = 25mm	S = 40mm	S = 75mm	
Chimney #3 (BH-90 to 93)	6.00	50m Dia.	--	50	--	--	--	FGL = (+) 375M
Chimney #2 (BH-100 to 103)	7.50	50m Dia.	--	50	--	--	--	FGL = (+) 375M
Chimney #1 (BH-111 to 114)	9.00	50m Dia.	--	50	--	--	--	FGL = (+) 375M
Absorber #2 & #3 (BH-94 & 105)	1.00	Upto 6	23	23	--	--	--	FGL = (+) 375M
		≥ 6	56	40	--	--	--	
	2.00	Upto 6	45	45	--	--	--	
		≥ 6	71	45	--	--	--	
Absorber #1 (BH-115)	1.50	Upto 6	20	--	--	8	--	FGL = (+) 375M
		≥ 6	19	--	--	--	10	
	3.00	Upto 6	60	30	--	--	--	
		≥ 6	78	35	--	--	--	
FGD C. Room #3 & Air Cooled Chiller Pump House (BH-96 & 98)	1.00	Upto 6	23	23	--	--	--	FGL = (+) 375M
		≥ 6	56	40	--	--	--	
	2.00	Upto 6	45	45	--	--	--	
		≥ 6	71	45	--	--	--	
FGD C. Room #1 & #2 & Waste Water & Sec. Hydro Cyclone Feed Tanks, Waste water tank, Filtrate water tank and pumps area (BH-106, 110 & 107)	2.50	Upto 6	51	35	--	--	--	FGL = (+) 375M
		≥ 6	71	35	--	--	--	
	3.00	Upto 6	60	40	--	--	--	
		≥ 6	78	40	--	--	--	
	5.00	Upto 6	112	45	--	--	--	
		≥ 6	122	45	--	--	--	
Limestone Grinding Bldg. (BH-117)	1.50	Upto 6	29	--	--	8	--	FGL = (+) 375M
		≥ 6	28	--	--	--	10	
	2.50	Upto 6	30	--	--	12	--	
		≥ 6	29	--	--	--	15	FGL = (+) 375M
	4.00	Upto 6	81	30	--	--	--	
		≥ 6	94	35	--	--	--	
Aux. Boiler (BH-118)	1.00 - 2.20	Filled up soil						FGL = (+) 375M
	3.50	Upto 6	10	--	--	8	--	
		≥ 6	11	--	--	--	10	
	4.50	Upto 6	91	--	--	12	--	
		≥ 6	102	--	--	--	15	
	5.50	Upto 6	111	30	--	--	--	
		≥ 6	118	35	--	--	--	
LHP-GYPSU Dewatering Building (BH-119)	2.00	Upto 6	10	--	--	8	--	FGL = (+) 375M
		≥ 6	10	--	--	--	10	
	3.00	Upto 6	49	--	--	12	--	
		≥ 6	48	--	--	--	15	
	4.50	Upto 6	91	30	--	--	--	
		≥ 6	102	35	--	--	--	
Canteen, (BH-120)	1.00	Upto 6	23	23	--	--	--	FGL = (+) 375M
		≥ 6	56	40	--	--	--	
	2.00	Upto 6	45	45	--	--	--	
		≥ 6	71	45	--	--	--	

Foundation Location	Df below FGL (M)	Width of Foundation (m)	NSBC (t/sqm)	NABC (t/sqm)				Remarks
				S = 12mm	S = 25mm	S = 40mm	S = 75mm	
Safety Park & Time Office (BH-121 to 122)	2.50	Upto 6	24	--	--	8	--	FGL = (+) 382M
		≥ 6	23	--	--	--	10	
	3.50	Upto 6	25	--	--	12	--	
		≥ 6	24	--	--	--	15	
	4.50	Upto 6	26	--	15	18	--	
		≥ 6	24	--	--	--	20	
	6.50	Upto 6	131	30	--	--	--	
		≥ 6	135	35	--	--	--	
Admin Building, IT Building & Auditorium (BH-123 to 125 & 189)	1.00	Upto 6	18	--	--	8	--	FGL = (+) 382M
		≥ 6	18	--	--	--	10	
	2.00	Upto 6	19	--	--	12	--	
		≥ 6	18	--	--	--	15	
	3.00	Upto 6	20	--	15	18	--	
		≥ 6	19	--	--	--	20	
	4.50	Upto 6	91	30	--	--	--	
		≥ 6	102	35	--	--	--	
Owner's Office (BH-126)	1.00	Upto 6	13	--	--	8	--	FGL = (+) 378M
		≥ 6	12	--	--	--	10	
	2.50	Upto 6	51	30	--	--	--	
		≥ 6	71	35	--	--	--	
Fire Water Tank & Pump house & FQA Building Area (BH-127)	1.00 - 3.80	Filled up soil						FGL = (+) 378M
	5.00	Upto 6	21	--	--	8	--	
		≥ 6	20	--	--	--	10	
	6.00	Upto 6	24	--	--	12	--	
		≥ 6	23	--	--	--	15	
	7.50	Upto 6	151	30	--	--	--	
		≥ 6	153	35	--	--	--	
Fire Station Building & Drill Tower Area (BH-128)	1.00 - 2.83	Filled up soil						FGL = (+) 378M
	4.00	Upto 6	9	--	--	8	--	
		≥ 6	8	--	--	--	8	
	5.00	Upto 6	29	--	--	12	--	
		≥ 6	31	--	--	--	15	
	6.50	Upto 6	131	30	--	--	--	
		≥ 6	135	35	--	--	--	
ACW PH (BH-129)	1.0 - 1.8	Filled up soil						FGL = (+) 378M
	6.00	Upto 6	121	30	--	--	--	
		≥ 6	127	35	--	--	--	
ACW Cooling Tower (BH-130, 132 & 133)	2.50	Upto 6	7	--	--	7	--	FGL = (+) 378M
		≥ 6	9	--	--	--	9	
	4.00	Upto 6	81	30	--	--	--	
		≥ 6	94	35	--	--	--	
ACW Cooling Tower (BH-131)	upto 0.9m	Filled up soil						FGL = (+) 378M
	2.00	Upto 6	29	--	--	8	--	
		≥ 6	27	--	--	--	10	
	4.00	Upto 6	11	--	--	11	--	
		≥ 6	13	--	--	--	13	
	8.50	Upto 6	171	30	--	--	--	
		≥ 6	172	35	--	--	--	

Foundation Location	Df below FGL (M)	Width of Foundation (m)	NSBC (t/sqm)	NABC (t/sqm)				Remarks
				S = 12mm	S = 25mm	S = 40mm	S = 75mm	
ClO_2 Dosing System (BH-134)	1.00	Upto 6	21	--	--	8	--	FGL = (+) 378M
		≥ 6	50	--	--	--	10	
	2.00	Upto 6	40	30	--	--	--	
		≥ 6	64	35	--	--	--	
	2.50	Upto 6	51	40	--	--	--	
		≥ 6	71	40	--	--	--	
Chemical Lab (BH-135)	1.00	Upto 6	21	20	--	--	--	FGL = (+) 378M
		≥ 6	50	35	--	--	--	
	2.00	Upto 6	45	40	--	--	--	
		≥ 6	71	40	--	--	--	
Chemical Storage & ACW Treat. System (BH-136 & 137)	1.50	Upto 6	10	--	--	8	--	FGL = (+) 378M
		≥ 6	10	--	--	--	10	
	2.50	Upto 6	11	--	--	11	--	
		≥ 6	10	--	--	--	10	
	3.50	Upto 6	70	30	--	--	--	
		≥ 6	86	35	--	--	--	
CPU Regn. (BH-138 & 139)	Upto 1.69m	Filled up soil						FGL = (+) 378M
	3.00	Upto 6	60	30	--	--	--	
		≥ 6	78	35	--	--	--	
RO-DM Plant & N Pit Area (BH-140 & 141)	1.50	Upto 6	9	--	--	8	--	FGL = (+) 378M
		≥ 6	9	--	--	--	9	
	2.50	Upto 6	14	--	--	12	--	
		≥ 6	19	--	--	--	15	
	3.50	Upto 6	70	30	--	--	--	
		≥ 6	86	35	--	--	--	
PT Plant & Clarified Water Reservoir Area (BH-142 to 144)	1.00	Upto 6	3	--	--	3	--	FGL = (+) 378M
		≥ 6	6	--	--	--	6	
	2.50	Upto 6	51	30	--	--	--	
		≥ 6	71	35	--	--	--	
DM Water Tank & Transfer Pump Stn. (BH-145 & 146)	1.50	Upto 6	30	30	--	--	--	FGL = (+) 378M
		≥ 6	57	35	--	--	--	
	2.00	Upto 6	40	40	--	--	--	
		≥ 6	64	40	--	--	--	
ZLD for FGD, O & M Store & Pump House (BH-147 to 149)	1.00	Upto 6	23	23	--	--	--	FGL = (+) 378M
		≥ 6	56	40	--	--	--	
	2.00	Upto 6	45	45	--	--	--	
		> 6	71	45	--	--	--	
PT Plant & Clarified Water Reservoir Area (BH-150)	1.00	Upto 6	21	21	--	--	--	FGL = (+) 378M
		≥ 6	50	35	--	--	--	
	2.00	Upto 6	40	40	--	--	--	
		≥ 6	64	40	--	--	--	
Workshop, Owner's Store & STP (BH-151 to 153)	1.00	Upto 6	23	23	--	--	--	FGL = (+) 378M
		≥ 6	56	40	--	--	--	
	2.00	Upto 6	45	45	--	--	--	
		≥ 6	71	50	--	--	--	
Construction Stores (BH-154)	Upto 4.8m	Filled up soil						FGL = (+) 378M
	6.00	Upto 6	27	--	--	8	--	
		≥ 6	25	--	--	--	10	
	7.50	Upto 6	151	30	--	--	--	
		≥ 6	153	35	--	--	--	
	8.00	Upto 6	161	40	--	--	--	
		≥ 6	162	40	--	--	--	

Foundation Location	Df below FGL (M)	Width of Foundation (m)	NSBC (t/sqm)	NABC (t/sqm)				Remarks
				S = 12mm	S = 25mm	S = 40mm	S = 75mm	
Ammonia Storage (BH-155)	1.00	Upto 6	22	--	--	8	--	FGL = (+) 373M
		≥ 6	21	--	--	--	10	
	2.00	Upto 6	40	30	--	--	--	
		≥ 6	64	35	--	--	--	
Foam PH & Fuel Oil Pump House (BH-156 & 157)	1.00	Upto 6	6	--	--	6	--	FGL = (+) 373M
		≥ 6	13	--	--	--	10	
	2.00	Upto 6	11	--	--	11	--	
		≥ 6	17	--	--	--	15	
	3.50	Upto 6	70	30	--	--	--	
		≥ 6	86	35	--	--	--	
H_2 Generation Plant (BH-167)	4.00	Upto 6	28	--	--	8	--	FGL = (+) 372M
		≥ 6	27	--	--	--	10	
	5.00	Upto 6	29	--	--	12	--	
		≥ 6	27	--	--	--	15	
	6.00	Upto 6	121	--	15	18	--	
		≥ 6	127	--	--	--	20	
	6.50	Upto 6	131	30	--	--	--	
		≥ 6	135	35	--	--	--	

Foundation Location	Df below EGL (M)	Width of Foundation (m)	NSBC (t/sqm)	NABC (t/sqm)				Remarks
				S = 12mm	S = 25mm	S = 40mm	S = 75mm	
Boundary Wall for Existing Plant Area (BH-158)	1.00	Upto 6	6	--	--	6	--	
		≥ 6	13	--	--	--	10	
	2.00	Upto 6	11	--	--	11	--	
		≥ 6	17	--	--	--	15	
	3.00	Upto 6	60	--	15	18	--	
		≥ 6	78	--	--	--	20	
	3.50	Upto 6	70	30	--	--	--	
		≥ 6	86	35	--	--	--	
Boundary Wall for Existing Plant Area (BH-159)	1.00	Upto 6	21	--	--	8	--	
		≥ 6	50	--	--	--	10	
	2.00	Upto 6	40	--	--	12	--	
		≥ 6	64	--	--	--	15	
	2.50	Upto 6	40	30	--	--	--	
		≥ 6	64	35	--	--	--	
Boundary Wall for Existing Plant Area (BH-160)	1.00 – 2.50	Filled up soil						
	3.50	Upto 6	30	--	--	8	--	
		≥ 6	29	--	--	--	10	
	4.50	Upto 6	31	--	--	12	--	
		≥ 6	29	--	--	--	15	
Boundary Wall for Existing Plant Area (BH-160)	5.50	Upto 6	40	--	15	18	--	
		≥ 6	37	--	--	--	20	
	6.00	Upto 6	121	30	--	--	--	
		≥ 6	127	35	--	--	--	
Boundary Wall for Existing Plant Area (BH-161)	1.00 – 3.00	Filled up soil						
	4.00	Upto 6	21	--	--	8	--	
		≥ 6	20	--	--	--	10	
	5.00	Upto 6	100	30	--	--	--	
		≥ 6	110	35	--	--	--	
Boundary Wall for Existing Plant Area (BH-162)	1.00	Upto 6	16	--	--	8	--	
		≥ 6	16	--	--	--	10	
	2.00	Upto 6	16	--	--	10	--	
		≥ 6	16	--	--	--	15	

Foundation Location	Df below EGL (M)	Width of Foundation (m)	NSBC (t/sqm)	NABC (t/sqm)				Remarks
				S = 12mm	S = 25mm	S = 40mm	S = 75mm	
Boundary Wall for Existing Plant Area (BH-162)	3.00	Upto 6	17	--	15	17	--	
		≥ 6	21	--	--	--	20	
	6.50	Upto 6	131	30	--	--	--	
		≥ 6	135	35	--	--	--	
Boundary Wall for Existing Plant Area (BH-163)	1.00	Upto 6	19	--	--	8	--	
		≥ 6	19	--	--	--	10	
	2.00	Upto 6	20	--	--	12	--	
		≥ 6	20	--	--	--	15	
	3.00	Upto 6	34	--	15	18	--	
		≥ 6	44	--	--	--	20	
	6.50	Upto 6	131	30	--	--	--	
		≥ 6	135	35	--	--	--	
Boundary Wall for Existing Plant Area (BH-164)	1.00	Upto 6	12	--	--	8	--	
		≥ 6	12	--	--	--	10	
	2.00	Upto 6	13	--	--	12	--	
		≥ 6	13	--	--	--	13	
	3.00	Upto 6	49	--	15	18	--	
		≥ 6	48	--	--	--	20	
	4.00	Upto 6	81	30	--	--	--	
		≥ 6	94	35	--	--	--	
Boundary Wall for Existing Plant Area (BH-165)	1.00	Upto 6	9	--	--	8	--	
		≥ 6	9	--	--	--	9	
	2.00	Upto 6	9	--	--	9	--	
		≥ 6	9	--	--	--	9	
	3.00	Upto 6	10	--	10	10	--	
		≥ 6	9	--	--	--	9	
	4.50	Upto 6	51	30	--	---	--	
		≥ 6	48	35	--	--	--	
Boundary Wall for Existing Plant Area (BH-166)	1.00	Upto 6	23	--	--	8	--	
		≥ 6	23	--	--	--	10	
	2.00	Upto 6	24	--	--	12	--	
		≥ 6	23	--	--	--	15	
	3.00	Upto 6	24	--	15	18	--	
		≥ 6	24	--	--	--	20	
	5.50	Upto 6	111	30	--	--	--	
		≥ 6	118	35	--	--	--	
Boundary Wall for Existing Plant Area (IBH-24 & IBH-66)	1.00	Upto 6	12	--	--	8	--	
		≥ 6	12	--	--	--	10	
	2.00	Upto 6	13	--	--	10	--	
		≥ 6	13	--	--	--	13	
	3.00	Upto 6	13	--	13	13	--	
		≥ 6	13	--	--	--	13	
	4.50	Upto 6	91	30	--	--	--	
		≥ 6	102	35	--	--	--	
Boundary Wall for Existing Plant Area (IBH-25)	1.00	Upto 6	19	--	--	8	--	
		≥ 6	19	--	--	--	10	
	2.00	Upto 6	20	--	--	12	--	
		≥ 6	20	--	--	--	15	
	3.00	Upto 6	60	30	--	--	--	
		≥ 6	78	35	--	--	--	

Foundation Location	Df below EGL (M)	Width of Foundation (m)	NSBC (t/sqm)	NABC (t/sqm)				Remarks
				S = 12mm	S = 25mm	S = 40mm	S = 75mm	
Boundary Wall for Existing Plant Area (IBH-44)	1.50	Upto 6	30	30	--	--	--	
		≥ 6	57	35	--	--	--	
Boundary Wall for Existing Plant Area (IBH-65)	1.00	Upto 6	16	--	--	8	--	
		≥ 6	16	--	--	--	10	
	2.00	Upto 6	18	--	--	12	--	
		≥ 6	16	--	--	--	15	
	3.00	Upto 6	21	--	15	18	--	
		≥ 6	20	--	--	--	20	
	4.50	Upto 6	91	30	--	--	--	
		≥ 6	102	35	--	--	--	
Boundary Wall for Existing Plant Area (IBH-67)	1.50	Upto 6	30	30	--	--	--	
		≥ 6	57	35	--	--	--	
	2.00	Upto 6	40	40	--	--	--	
		≥ 6	64	40	--	--	--	
Boundary Wall for Existing Plant Area (IBH-73)	1.00	Upto 6	12	--	--	8	--	
		≥ 6	12	--	--	--	10	
	2.00	Upto 6	13	--	--	12	--	
		≥ 6	13	--	--	--	13	
	3.00	Upto 6	49	--	15	18	--	
		≥ 6	48	--	--	--	20	
	3.50	Upto 6	70	30	--	--	--	
		≥ 6	86	35	--	--	--	
Proposed Plant Boundary (BH-121)	1.00 – 1.70	Filled up soil						
	3.00	Upto 6	22	--	--	8	--	
		≥ 6	21	--	--	--	10	
	4.00	Upto 6	23	--	--	12	--	
		≥ 6	22	--	--	--	15	
	5.00	Upto 6	52	--	15	18	--	
		≥ 6	49	--	--	--	20	
	7.00	Upto 6	141	30	--	--	--	
		≥ 6	144	35	--	--	--	
Proposed Plant Boundary (BH-122)	1.00	Upto 6	23	--	--	8	--	
		≥ 6	23	--	--	--	10	
	2.00	Upto 6	24	--	--	12	--	
		≥ 6	23	--	--	--	15	
	3.00	Upto 6	24	--	15	18	--	
		≥ 6	24	--	--	--	20	
	5.50	Upto 6	111	30	--	--	--	
		≥ 6	118	35	--	--	--	

Foundation Location	Df below EGL (M)	Width of Foundation (m)	NSBC (t/sqm)	NABC (t/sqm)				Remarks
				S = 12mm	S = 25mm	S = 40mm	S = 75mm	
Proposed Plant Boundary (BH-168 & 169)	1.00	Upto 6	23	--	--	8	--	
		≥ 6	23	--	--	--	10	
	2.00	Upto 6	24	--	--	12	--	
		≥ 6	23	--	--	--	15	
	3.00	Upto 6	29	--	15	18	--	
		≥ 6	28	--	--	--	20	
	3.50	Upto 6	70	30	--	--	--	
		≥ 6	86	35	--	--	--	
	4.50	Upto 6	91	40	--	--	--	
		≥ 6	102	40	--	--	--	
	6.00-10.00	Upto 6	91	45	--	--	--	
		≥ 6	102	45	--	--	--	
Proposed Plant Boundary (BH-170 & 171)	1.00	Upto 6	12	--	--	7	--	
		≥ 6	12	--	--	--	10	
	2.00	Upto 6	13	--	--	9	--	
		≥ 6	13	--	--	--	13	
	3.00	Upto 6	13	--	7	12	--	
		≥ 6	13	--	--	--	13	
	4.00	Upto 6	18	--	15	18	--	
		≥ 6	17	--	--	--	17	
	5.50	Upto 6	111	30	--	--	--	
		≥ 6	118	35	--	--	--	
	6.50	Upto 6	131	40	--	--	--	
		≥ 6	135	40	--	--	--	
	7.50-10.00	Upto 6	169	45	--	--	--	
		≥ 6	171	45	--	--	--	
Proposed Plant Boundary (BH-172)	1.00 – 2.45	Filled up soil						
	3.50	Upto 6	26	--	--	8	--	
		≥ 6	25	--	--	--	10	
	4.50	Upto 6	27	--	--	12	--	
		≥ 6	26	--	--	--	15	
	6.50	Upto 6	131	30	--	--	--	
		≥ 6	135	35	--	--	--	
Proposed Plant Boundary (BH-173)	1.50 – 2.00	Upto 6	21	--	--	8	--	
		≥ 6	40	--	--	--	10	
	3.00	Upto 6	26	--	--	12	--	
		≥ 6	25	--	--	--	15	
	4.00	Upto 6	25	--	--	18	--	
		≥ 6	24	--	--	--	20	
	5.50	Upto 6	26	--	15	18	--	
		≥ 6	25	--	--	--	20	
	9.50	Upto 6	191	30	--	--	--	
		≥ 6	191	35	--	--	--	
Proposed Plant Boundary (BH-174)	1.00	Upto 6	19	--	--	8	--	
		≥ 6	19	--	--	--	10	
	2.00	Upto 6	20	--	--	12	--	
		≥ 6	20	--	--	--	15	
	3.00	Upto 6	34	--	15	18	--	
		≥ 6	44	--	--	--	20	
	5.50	Upto 6	111	30	--	--	--	
		≥ 6	118	35	--	--	--	

Foundation Location	Df below EGL (M)	Width of Foundation (m)	NSBC (t/sqm)	NABC (t/sqm)				Remarks
				S = 12mm	S = 25mm	S = 40mm	S = 75mm	
Proposed Plant Boundary (BH-175 to 181)	1.00 – 5.00	Filled up soil						
	6.50	Upto 6	149	30	--	--	--	
		≥ 6	149	35	--	--	--	
Proposed Plant Boundary (BH-182)	1.00	Upto 6	23	--	--	8	--	
		≥ 6	23	--	--	--	10	
	2.00	Upto 6	40	--	--	12	--	
		≥ 6	64	--	--	--	15	
	2.50	Upto 6	51	30	--	--	--	
		≥ 6	71	35	--	--	--	
Proposed Plant Boundary (BH-183 & 184)	1.00	Upto 6	23	--	--	8	--	
		≥ 6	23	--	--	--	10	
	2.00	Upto 6	24	--	--	12	--	
		≥ 6	23	--	--	--	15	
	3.00	Upto 6	60	--	--	18	--	
		≥ 6	78	--	--	--	20	
	3.50	Upto 6	70	30	--	--	--	
		≥ 6	86	35	--	--	--	
Proposed Plant Boundary (BH-185)	1.00	Upto 6	16	--	--	8	--	
		≥ 6	16	--	--	--	10	
	2.00	Upto 6	16	--	--	10	--	
		≥ 6	16	--	--	--	15	
	3.00	Upto 6	17	--	15	17	--	
		≥ 6	21	--	--	--	20	
	6.50	Upto 6	131	30	--	--	---	
		≥ 6	135	35	--	--	--	
Proposed Plant Boundary (BH-186)	1.00	Upto 6	19	--	--	8	--	
		≥ 6	19	--	--	--	10	
	2.00	Upto 6	20	--	--	12	--	
		≥ 6	20	--	--	--	15	
	3.00	Upto 6	34	--	15	18	--	
		≥ 6	44	--	--	--	20	
	4.50	Upto 6	91	30	--	--	--	
		≥ 6	102	35	--	--	--	
Proposed Plant Boundary (BH-187)	1.00	Upto 6	19	--	--	8	--	
		≥ 6	19	--	--	--	10	
	2.00	Upto 6	20	--	--	12	--	
		≥ 6	20	--	--	--	15	
	3.00	Upto 6	24	--	15	18	--	
		≥ 6	24	--	--	--	20	
	4.50	Upto 6	91	30	--	--	--	
		≥ 6	102	35	--	--	--	
Proposed Plant Boundary (BH-188)	1.00	Upto 6	12	--	--	8	--	
		≥ 6	12	--	--	--	10	
	2.00	Upto 6	13	--	--	10	--	
		≥ 6	13	--	--	--	13	
	3.00	Upto 6	13	--	13	13	--	
		≥ 6	13	--	--	--	13	
	4.50	Upto 6	91	30	--	--	--	
		≥ 6	102	35	--	--	--	

Foundation Location	Df below EGL (M)	Width of Foundation (m)	NSBC (t/sqm)	NABC (t/sqm)				Remarks
				S = 12mm	S = 25mm	S = 40mm	S = 75mm	
Proposed Plant Boundary (IBH-61)	1.00	Upto 6	19	--	--	7	--	
		≥ 6	19	--	--	--	10	
	2.00	Upto 6	20	--	--	9	--	
		≥ 6	20	--	--	--	13	
	3.00	Upto 6	21	--	7	11	--	
		≥ 6	20	--	--	--	17	
	4.00	Upto 6	21	--	11	18	--	
		≥ 6	20	--	--	--	20	
	8.50	Upto 6	171	30	--	--	--	
		≥ 6	172	35	--	--	--	
Proposed Plant Boundary (IBH-62)	2.00	Upto 6	13	--	--	12	--	
		≥ 6	13	--	--	--	13	
	3.00	Upto 6	13	--	13	13	--	
		≥ 6	13	--	--	--	13	
	4.00	Upto 6	25	--	11	18	--	
Proposed Plant Boundary (IBH-62)	4.00	≥ 6	24	--	--	--	20	
	6.50	Upto 6	131	30	--	--	--	
		≥ 6	135	35	--	--	--	
Proposed Plant Boundary (IBH-63)	1.00	Upto 6	12	--	--	8	--	
		≥ 6	12	--	--	--	10	
	2.00	Upto 6	13	--	--	12	--	
		≥ 6	13	--	--	--	13	
	3.00	Upto 6	13	--	13	13	--	
		≥ 6	13	--	--	--	13	
	4.00	Upto 6	25	--	15	18	--	
		≥ 6	24	--	--	--	20	
	7.00	Upto 6	141	30	--	--	--	
		≥ 6	144	35	--	--	--	

Note:

1. NSBC = Net Safe Bearing Capacity, NABC = Net Allowable Bearing Capacity,EGL = Existing Ground Level& S = Limiting Settlement.
2. L/B ratio = 2 is considered for SBC calculation.
3. In case any loose pocket is observed at the founding level, then the same should be excavated out and filled up with PCC.
4. The roads, ground floor slabs, trenches, pipe pedestals, channels/drains and staircase foundation with foundation loading intensity less than 4 t/sqm may be supported on open / shallow foundation resting on virgin / controlled compacted filled up soil.

5. The discussion on swelling characteristics is given in Section 5.04**.**

6. Chemical tests were carried out on a few soil and water samples so as to detect the **pH value, Sulphate, Chloride etc**. It is seen that the values are on a safe side. So, any cement can be used for foundation concrete. **Either Ordinary Portland cement or Portland slag cement or Portland Pozzolana cement can be used for the purpose.**

7. The suitability of existing soil for filling and back-filling is given in Section 5.08.

8. The suitability of soil for construction of roads & pavement is discussed in Section 5.09.

9. The earth pressure coefficient for in-situ active & passive state is given in Section 5.10.

10. Geological report along with geological logging of the rock core samples for the zone of investigation is presented in Section -7.

For C. E. Testing Company Private Limited,

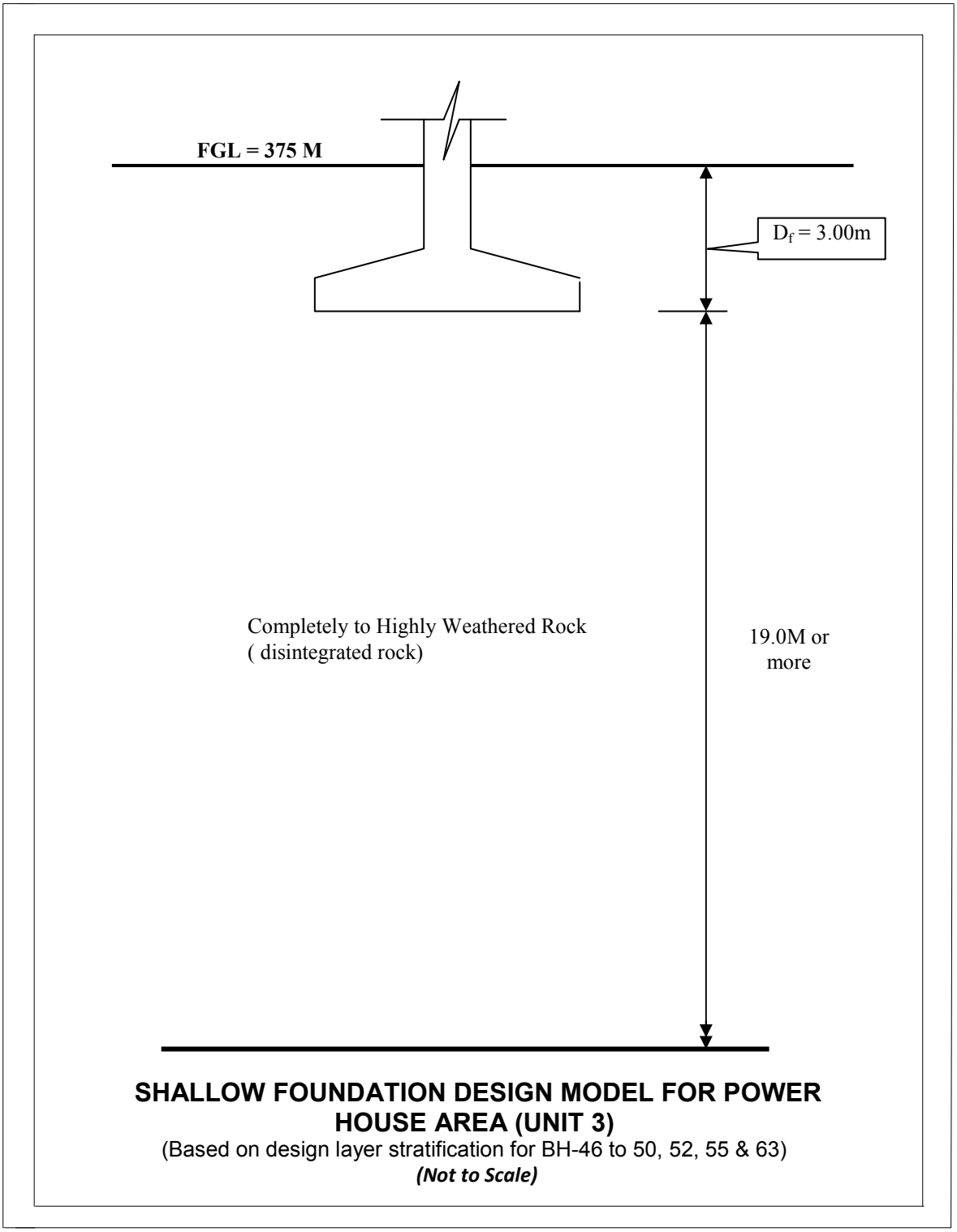
Prepared By	Checked By	Approved By
(A. DUTTA)	(S. NATH)	(DR. M. NAYAK)

BEARING CAPACITY CALCULATIONS

SAMPLE CALCULATION FOR POWER HOUSE AREA (UNIT 3)

[Around BH-46 to 50, 52, 55 & 63]

Let us place the foundation at 3.00m below F.G.L. (+375 M). Founding level falls inside stratum – III & IV.



SHALLOW FOUNDATION DESIGN MODEL FOR POWER HOUSE AREA (UNIT 3)

(Based on design layer stratification for BH-46 to 50, 52, 55 & 63)

(Not to Scale)

BEARING CAPACITY BASED ON RMR METHOD:

Based on the geological observation so found from rock core samples the bearing capacity is calculated as follows:

Calculated RMR = 22 as per IS: 13365(Part1)-1998, Annex B

a) The average UCS value in layer III is taken as 57 kg/sqcm. Corresponding rating = 1
b) RQD value, a minimum of 10% is considered as per codal provision (IS 13365, Part 1), corresponding rating = 03
c) Spacing of discontinuity taken as very close. corresponding rating = 05
d) Condition of discontinuity [Refer "Support of Underground Excavations in Hard Rock" by E. Hoek, P.K. Kaiser & W.F. Bawden, Table 4.4: Rock Mass Rating System (After Bieniawski, 1989) attached at the end of this report]
   I. Discontinuity length (persistence) taken as 1-3m, corresponding rating = 04
   II. Roughness considered as slightly rough, corresponding rating = 03
   III. Weathering condition considered as highly weathered, corresponding rating = 01
e) Ground water condition taken as Wet. corresponding rating = 07
f) Dip Angle Joint Orientation taken as favourable (based on geological formation), corresponding rating = (-)2

So, RMR = 01+03+05+04+03+01+07+(-)2 = 22

So, from Table-3 of IS: 12070 (Amendment 1, Nov. 2008) q_{ns} = 52.58 t/sqm (by interpolation) for 12mm settlement.
Hence, use a net allowable bearing capacity of 50 t/sqm for depth of foundation of 3.0m below FGL around power house area (unit 3) for BH-46 to 50, 52, 55 & 63.

SAMPLE CALCULATION FOR BOUNDARY WALL AROUND BH-165:

Let us place the foundation at 2.00m below EGL. Founding level falls inside stratum -IA.

Use design "N" in this layer = 06. So, estimated cohesion from "N" value = 0.40 kg/sqcm

From laboratory TRSH-UU test result, we have C = 0.61 kg/sqcm & $\Phi = 0°$

To be in safer side, use C = 0.40 kg/sqcm & $\Phi = 0°$

EVALUATION OF STRENGTH AND DEFORMATION PARAMETERS:

For Stratum IA

Total soil modulus, $E_s = 4.4 \times N = 26.40$ kg/sqcm

Undrained Young's modulus, $E_u = K \times C = 300 \times 0.40 = 120$ kg/sqcm

Again, $1/E_s = 1/E_u + 1/E_d$ giving drained young's modulus, $E_d = 33.85$kg/sqcm

Now, we have, $E_d = E_u/3 = 40$ kg/sqcm

Considering the above, let us use $E_d = 36$ kg/sqcm

From E_d, $m_{vc} = 1/G.E_d = 0.0309$ sqcm/kg [Geological Factor, G = 0.90 & μ = 0.35]

Again from SPT "N", $m_{vc} = 1/5N = 0.0333$ sqcm/kg

Now, let us consider the m_{vc} value for the pressure range between 0.25 to 1.00 kg/sqcm

Sample No.	0.25 – 0.50kg/sqcm	0.50 – 1.00kg/sqcm
BH-165/UDS01	0.0257	0.0174
Average weighted m_{vc}over entire pressure range	**0.0202**	

Giving more weightage to the laboratory test results,

Thus average $m_{vc} = [2 \times 0.0202 + 0.0333 + 0.0309]/4 = 0.0261$ sqcm/kg

For Stratum I

Use design "N" in this layer = 33.

To be in conservative side, use C = 1.20 kg/sqcm & $\Phi = 0°$

Total soil modulus, $E_s = 4.4 \times N = 145.2$ kg/sqcm

Undrained Young's modulus, $E_u = K \times C = 500 \times 1.20 = 600$ kg/sqcm

Again, $1/E_s = 1/E_u + 1/E_d$ giving drained young's modulus, $E_d = 191.56$ kg/sqcm

Now, we have, $E_d = E_u/3 = 200$ kg/sqcm

Considering the above, let us use $E_d = 195$ kg/sqcm

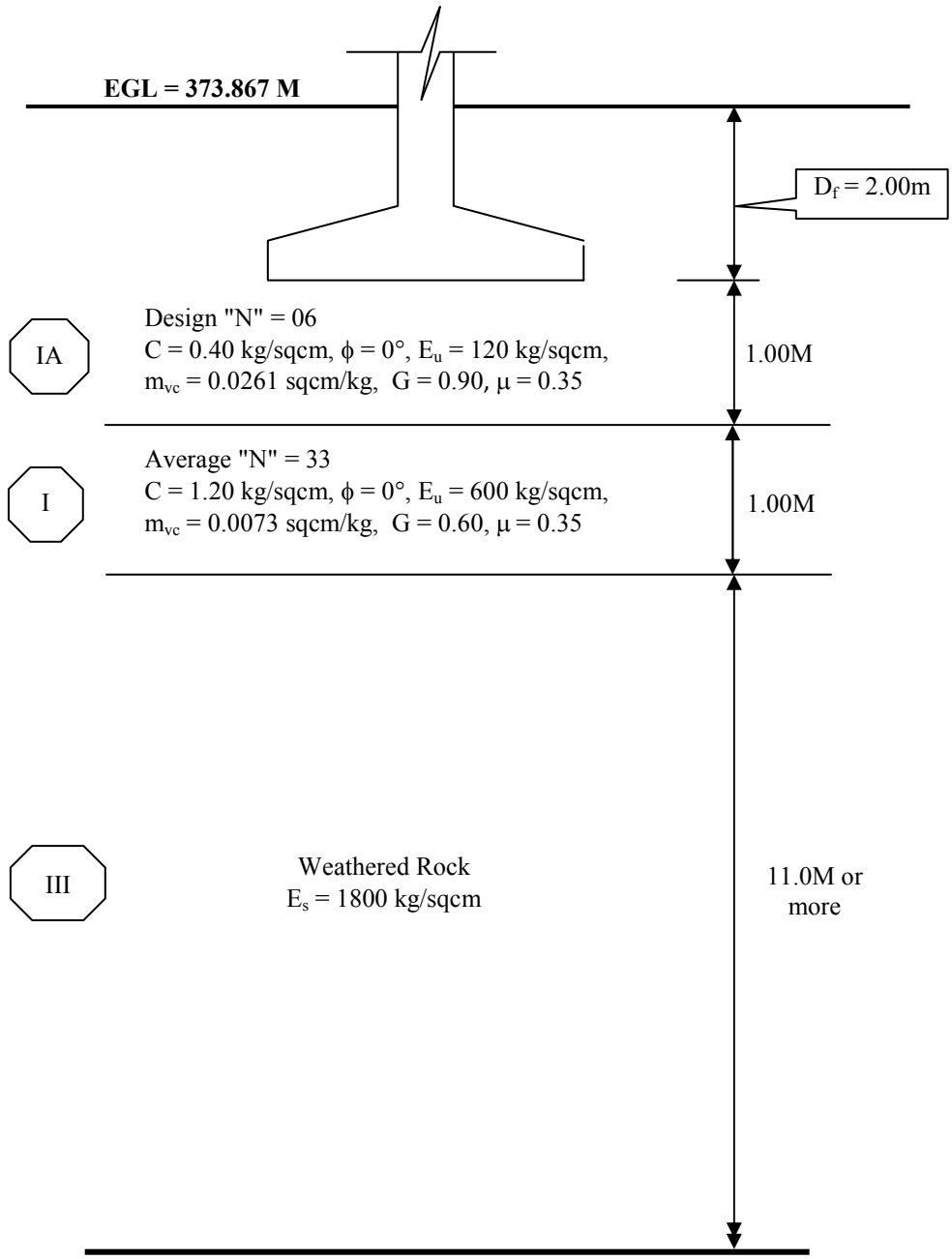
From E_d, $m_{vc} = 1/G.E_d = 0.0085$ sqcm/kg [Geological Factor, G = 0.60 & μ = 0.35]

Again from SPT "N", $m_{vc} = 1/5N = 0.0061$ sqcm/kg

Thus average $m_{vc} = [0.0061 + 0.0085]/2 = 0.0073$ sqcm/kg

For Rock layers

Use the Young's Modulus value of the weathered rock layer = 1800 kg/cm^2



SHALLOW FOUNDATION DESIGN MODEL FOR BOUNDARY WALL

(Based on design layer stratification around BH-165)

(Not to Scale)

CALCULATION OF NET SAFE BEARING CAPACITY:

The Net Ultimate Bearing Capacity is given as:

$q_{nu} = C.N_c.S_c.D_c + q.N_q.S_q.D_q + 0.5\gamma.B.N_\gamma.S_\gamma.D_\gamma - q$

Where,

N_c, N_q and N_γ are bearing capacity factors,
S_c, S_q and S_γ are shape factors,
D_c, D_q and D_γ are depth factors,

And

C = Cohesion
q = Overburden pressure,
B = Width of foundation,
γ = Effective density below foundation.

For 6m x 12m Rectangular Isolated Footing

Cohesion, C = 4.00 t/sqm
Using ϕ = 0 degree, the bearing capacity factors are:

$N_c = 5.14$
$N_q = 1.00$
$N_\gamma = 0.00$

Use,

Depth of Foundation = D_f = 2.00 M (below EGL)
Width of Foundation = B = 6 M
Length of Foundation = L = 12 M

Overburden Pressure = q =2.000 (Depth) x 0.90 (Submerged density) = 1.80 t/sqm (assuming the ground water table is flushing with the ground level)

The Shape factors are [IS:6403 - 1981]

$S_c = 1.10$ $S_q = 1.10$ $S_\gamma = 0.80$

The Depth factors are [IS:6403 - 1981]

$D_c = 1.07$ $D_q = 1.00$ $D_\gamma = 1.00$

Computed Net Ultimate Bearing Capacity = 24.33 t/sqm

Using a factor of safety of 2.5, Net Safe Bearing Capacity = 9.73 t/sqm

The above bearing capacity should be checked against settlement criteria.

SETTLEMENT CALCULATION:

With reference to the above, the settlement is calculated and presented below:

Settlement Analysis

A) General Data:

Width of foundation =	6.0	m
Length of foundation =	12.0	m
Depth of foundation =	2.0	m
Net Base Pressure =	0.9	kg/sqcm

B) Subsoil Properties:

Layer - IA			Layer - I			Layer - III		
Young's Modulus =	120	kg/sqcm	Young's Modulus =	600	kg/sqcm	Young's Modulus =	1800	kg/sqcm
Poisson Ratio, μ =	0.35		Poisson Ratio, μ =	0.35		Poisson Ratio, μ =	0.25	
Top of Stratum =	2.00	m	Top of Stratum =	3.00	m	Top of Stratum =	4	m
End of Stratum =	3.00	m	End of Stratum =	4.00	m	End of Stratum =	14	m
Geological factor, G =	0.90		Geological factor, G =	0.60		Geological factor, G =	1	
m_{vc} =	0.0261	sqcm/kg	m_{vc} =	0.0073	sqcm/kg	m_{vc} =	0.0000	sqcm/kg

C) Calculation of Immediate Settlement:

Settlement at center			*Settlement at center*			*Settlement at center*		
M = L' / B' =	2.000		M = L' / B' =	1.857		M = L' / B' =	1.750	
N = H / B' =	0.333		N = H / B' =	0.286		N = H / B' =	2.500	
I_1 =	0.019		I_1 =	0.014		I_1 =	0.351	
I_2 =	0.064		I_2 =	0.057		I_2 =	0.085	
$I_s = I_1 + \{(1-2\mu) / (1-\mu)\} I_2$ =		0.048	$I_s = I_1 + \{(1-2\mu) / (1-\mu)\} I_2$ =		0.041	$I_s = I_1 + \{(1-2\mu) / (1-\mu)\} I_2$ =		0.408
Immediate settlement S_i =		0.383 cm	Immediate settlement S_i =		0.059 cm	Immediate settlement S_i =		0.197 cm
$[q_o \times B' \times (1-\mu^2) \times m \times I_s] / E_s$			$[q_o \times B' \times (1-\mu^2) \times m \times I_s] / E_s$			$[q_o \times B' \times (1-\mu^2) \times m \times I_s] / E_s$		

Settlement at corner			*Settlement at corner*			*Settlement at corner*		
M = L' / B' =	2.00		M = L' / B' =	1.86		M = L' / B' =	1.750	
N = H / B' =	0.167		N = H / B' =	0.143		N = H / B' =	1.250	
I_1 =	0.004879		I_1 =	0.004		I_1 =	0.174	
I_2 =	0.036767		I_2 =	0.032		I_2 =	0.106	
$I_s = I_1 + \{(1-2\mu) / (1-\mu)\} I_2$ =		0.022	$I_s = I_1 + \{(1-2\mu) / (1-\mu)\} I_2$ =		0.018	$I_s = I_1 + \{(1-2\mu) / (1-\mu)\} I_2$ =		0.244
Immediate settlement S_i =		0.086 cm	Immediate settlement S_i =		0.013 cm	Immediate settlement S_i =		0.059 cm

Average Si for Layer - IA =	2.34 mm	Average Si for Layer - I =	0.36 mm	Average Si for Layer - III =	1.28 mm
Total immediate settlement =	3.99 mm	(for all the three layers)			

D) Calculation of Consolidation Settlement:

Strata	From (M)	To (M)	Thickness (M)	Mid depth (M)	ΔP (kg/sqcm)	m_{vc}, sqcm/kg	G	S_c (cm)
Layer - IA	2.00	2.50	0.50	0.25	0.85	0.0261	0.90	0.99
	2.50	3.00	0.50	0.75	0.75	0.0261	0.90	0.88
Layer - I	3.00	3.50	0.50	1.25	0.67	0.0073	0.60	0.15
	3.50	4.00	0.50	1.75	0.61	0.0073	0.60	0.13
Hence, Total Consolidation Settlement =								21.59 mm

So, Total Settlement =	25.58 mm
Fox's Depth correction Factor =	0.94
Corrected total settlement =	**24.01 mm**

So, a net allowable bearing capacity of 09 T/m^2 can be used for limiting settlement of 40mm.

SAMPLE CALCULATION FOR SWITCH YARD AREA

Considering the subsoil condition, let us place the foundation at 7.00m below F.G.L. (+372 M).

Founding level falls inside stratum -I.

Use design cohesion, C = 0.70 kg/sqcm & Φ = 0°

CALCULATION OF NET SAFE BEARING CAPACITY:

The Net Ultimate Bearing Capacity is given as:

$$q_{nu} = C.N_c.S_c.D_c + q.N_q.S_q.D_q + 0.5\gamma.B.N_\gamma.S_\gamma.D_\gamma - q$$

Where,

N_c, N_q and N_γ are bearing capacity factors,
S_c, S_q and S_γ are shape factors,
D_c, D_q and D_γ are depth factors,

And

C = Cohesion
q = Overburden pressure,
B = Width of foundation,
γ = Effective density below foundation.

For 6m x 12m Rectangular Isolated Footing

Cohesion, C = 7.00 t/sqm
Using ϕ = 0 degree, the bearing capacity factors are:

N_c = 5.14
N_q = 1.00
N_γ = 0.00

Use,

Depth of Foundation = D_f = 7.00 M (below FGL)
Width of Foundation = B = 6.00 M
Length of Foundation = L = 12.0 M

Overburden Pressure = q =7.000 (Depth) x 0.90 (Submerged density) = 6.30 t/sqm (assuming the ground water table is flushing with the ground level)

The Shape factors are [IS:6403 - 1981]

S_c = 1.10 S_q = 1.10 S_γ = 0.80

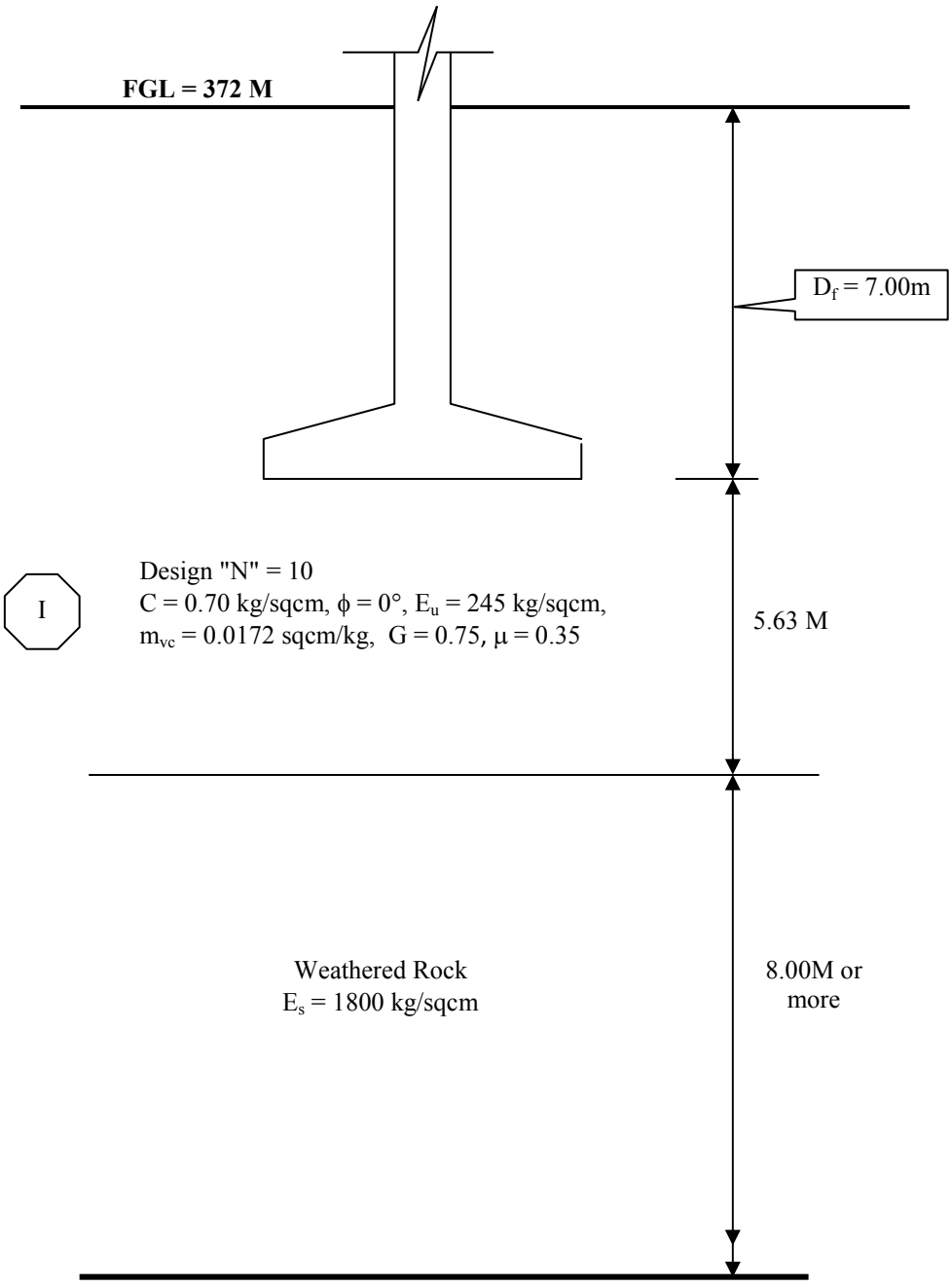
The Depth factors are [IS:6403 - 1981]

D_c = 1.23 D_q = 1.00 D_γ = 1.00

Computed Net Ultimate Bearing Capacity = 49.49 t/sqm

Using a factor of safety of 2.5, Net Safe Bearing Capacity = 19.80 t/sqm

The above bearing capacity should be checked against settlement criteria.



SHALLOW FOUNDATION DESIGN MODEL FOR SWITCH YARD

(Based on design layer stratification)

(Not to Scale)

SETTLEMENT CALCULATION:

With reference to the above, the settlement is calculated and presented below:

Settlement Analysis

A) General Data:

Width of foundation =	6.0	m
Length of foundation =	12.0	m
Depth of foundation =	7.0	m
Net Base Pressure =	1.0	kg/sqcm

B) Subsoil Properties:

Layer - I			**Layer - III**		
Young's Modulus =	245	kg/sqcm	Young's Modulus =	1800	kg/sqcm
Poisson Ratio, μ =	0.35		Poisson Ratio, μ =	0.25	
Top of Stratum =	7.00	m	Top of Stratum =	12.63	m
End of Stratum =	12.63	m	End of Stratum =	19.00	m
Geological factor, G =	0.75		Geological factor, G =	1.00	
m_{vc} =	0.0172	sqcm/kg	m_{vc} =	0.0000	sqcm/kg

C) Calculation of Immediate Settlement:

Settlement at center			*Settlement at center*		
M = L' / B' =	2.000		M = L' / B' =	1.516	
N = H / B' =	1.877		N = H / B' =	1.095	
I_1 =	0.272		I_1 =	0.149	
I_2 =	0.105		I_2 =	0.101	
$I_s = I_1 + \{(1-2\mu) / (1-\mu)\} I_2$ =	0.320		$I_s = I_1 + \{(1-2\mu) / (1-\mu)\} I_2$ =	0.217	
Immediate settlement S_i =	1.375	cm	Immediate settlement S_i =	0.092	cm
$[q_o \times B' \times (1-\mu^2) \times m \times I_s] / E_s$			$[q_o \times B' \times (1-\mu^2) \times m \times I_s] / E_s$		

Settlement at corner			*Settlement at corner*		
M = L' / B' =	2.00		M = L' / B' =	1.52	
N = H / B' =	0.938		N = H / B' =	0.548	
I_1 =	0.113832		I_1 =	0.050	
I_2 =	0.107684		I_2 =	0.085	
$I_s = I_1 + \{(1-2\mu) / (1-\mu)\} I_2$ =	0.164		$I_s = I_1 + \{(1-2\mu) / (1-\mu)\} I_2$ =	0.106	
Immediate settlement S_i =	0.351	cm	Immediate settlement S_i =	0.023	cm

Average Si for Layer - I =	8.63	mm	Average Si for Layer - III =	0.57	mm
Total immediate settlement =	9.21	mm	(for both the layer)		

D) Calculation of Consolidation Settlement:

Strata	From (M)	To (M)	Thickness (M)	Mid depth (M)	Δ P (kg/sqcm)	m_{vc}, sqcm/kg	G	S_c (cm)
Layer - I	7.00	9.82	2.82	1.41	0.72	0.0172	0.75	2.63
	9.82	12.63	2.82	4.22	0.43	0.0172	0.75	1.58
Hence, Total Consolidation Settlement =								42.09 mm

So, Total Settlement =	51.30	mm
Fox's Depth correction Factor =	0.76	
Corrected total settlement =	**39.16**	**mm**

However, let us restrict the net allowable bearing capacity to 08 T/m^2 for foundation placed at 1.5m below NGL for limiting settlement of 40mm.

SAMPLE CALCULATION FOR TRANSFORMER YARD & ACC AREA UNIT 1 (FOR BH-13)

Considering the subsoil condition, let us place the foundation at 2.50m below F.G.L. (+375 M).

Founding level falls inside stratum -IA.

Use design cohesion, C = 0.65 kg/sqcm & Φ = 0°

CALCULATION OF NET SAFE BEARING CAPACITY:

The Net Ultimate Bearing Capacity is given as:

$$q_{nu} = C.N_c.S_c.D_c + q.N_q.S_q.D_q + 0.5\gamma.B.N_\gamma.S_\gamma.D_\gamma - q$$

Where,

N_c, N_q and N_γ are bearing capacity factors,
S_c, S_q and S_γ are shape factors,
D_c, D_q and D_γ are depth factors,

And

C = Cohesion
q = Overburden pressure,
B = Width of foundation,
γ = Effective density below foundation.

For 6m x 12m Rectangular Isolated Footing

Cohesion, C = 6.50 t/sqm
Using ϕ = 0 degree, the bearing capacity factors are:

N_c = 5.14
N_q = 1.00
N_γ = 0.00

Use,

Depth of Foundation = D_f = 2.50 M (below FGL)
Width of Foundation = B = 6.00 M
Length of Foundation = L = 12.0 M

Overburden Pressure = q =2.500 (Depth) x 0.90 (Submerged density) = 2.25 t/sqm (assuming the ground water table is flushing with the ground level)

The Shape factors are [IS:6403 - 1981]

S_c = 1.10 S_q = 1.10 S_γ = 0.80

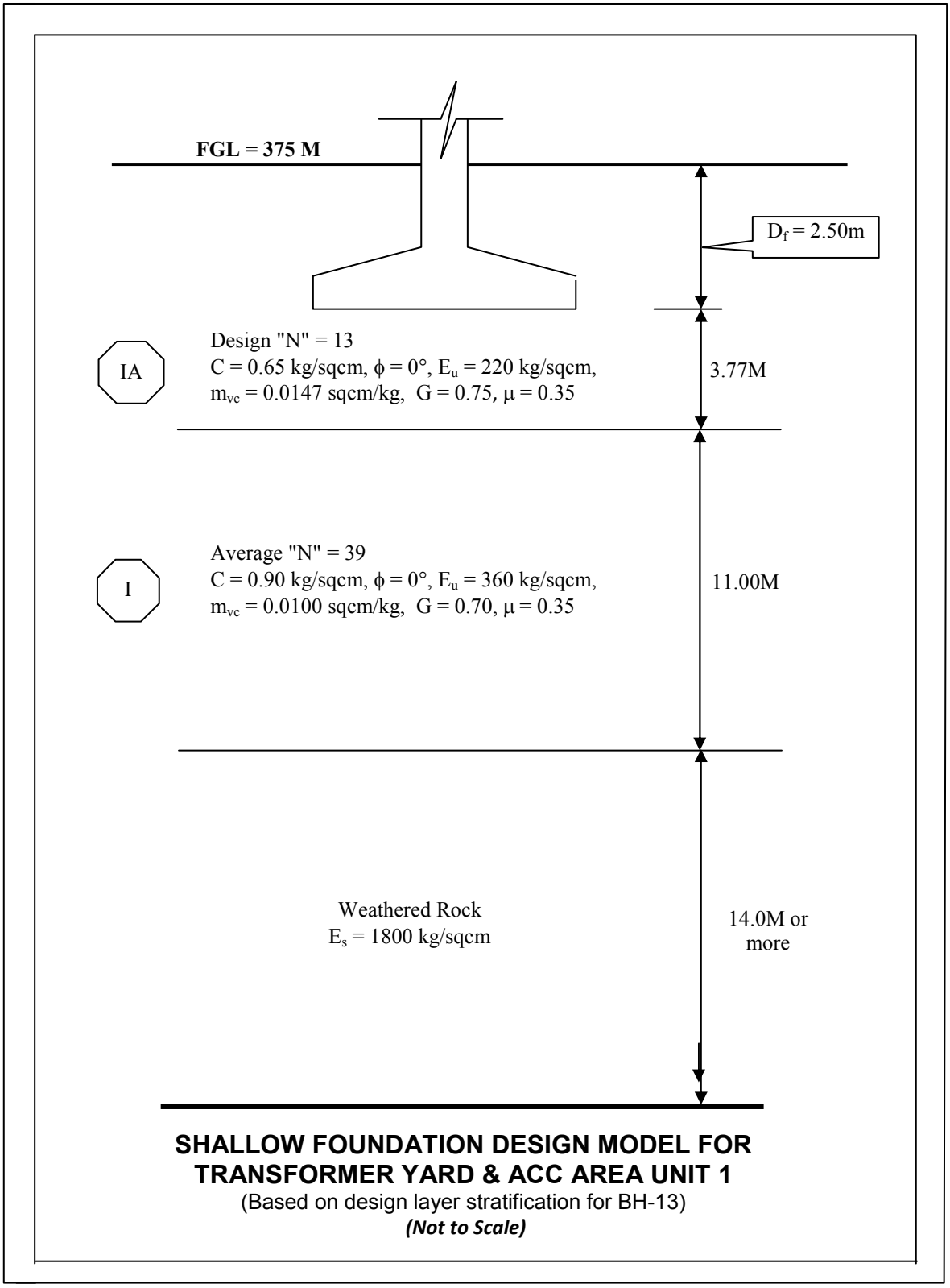
The Depth factors are [IS:6403 - 1981]

D_c = 1.08 D_q = 1.00 D_γ = 1.00

Computed Net Ultimate Bearing Capacity = 40.07 t/sqm

Using a factor of safety of 2.5, Net Safe Bearing Capacity = 16.03 t/sqm

The above bearing capacity should be checked against settlement criteria.



SHALLOW FOUNDATION DESIGN MODEL FOR TRANSFORMER YARD & ACC AREA UNIT 1

(Based on design layer stratification for BH-13)

(Not to Scale)

SETTLEMENT CALCULATION:

With reference to the above, the settlement is calculated and presented below:

Settlement Analysis

A) General Data:

Width of foundation =	6.0	m
Length of foundation =	12.0	m
Depth of foundation =	2.5	m
Net Base Pressure =	0.7	kg/sqcm

B) Subsoil Properties:

Layer - IA			**Layer - I**		
Young's Modulus =	220	kg/sqcm	Young's Modulus =	360	kg/sqcm
Poisson Ratio, μ =	0.35		Poisson Ratio, μ =	0.35	
Top of Stratum =	2.50	m	Top of Stratum =	6.27	m
End of Stratum =	6.27	m	End of Stratum =	14.50	m
Geological factor, G =	0.75		Geological factor, G =	0.70	
m_{vc} =	0.0147	sqcm/kg	m_{vc} =	0.0100	sqcm/kg

C) Calculation of Immediate Settlement:

Settlement at center			*Settlement at center*		
M = L' / B' =	2.000		M = L' / B' =	1.614	
N = H / B' =	1.257		N = H / B' =	1.685	
I_1 =	0.171		I_1 =	0.248	
I_2 =	0.111		I_2 =	0.097	
$I_s = I_1 + \{(1-2\mu) / (1-\mu)\} I_2$ =		0.223	$I_s = I_1 + \{(1-2\mu) / (1-\mu)\} I_2$ =		0.292
Immediate settlement S_i =		0.746 cm	Immediate settlement S_i =		0.455 cm
$[q_o \times B' \times (1-\mu^2) \times m \times I_s] / E_s$			$[q_o \times B' \times (1-\mu^2) \times m \times I_s] / E_s$		

Settlement at corner			*Settlement at corner*		
M = L' / B' =	2.00		M = L' / B' =	1.61	
N = H / B' =	0.628		N = H / B' =	0.842	
I_1 =	0.059666		I_1 =	0.101	
I_2 =	0.094043		I_2 =	0.100	
$I_s = I_1 + \{(1-2\mu) / (1-\mu)\} I_2$ =		0.103	$I_s = I_1 + \{(1-2\mu) / (1-\mu)\} I_2$ =		0.147
Immediate settlement S_i =		0.173 cm	Immediate settlement S_i =		0.114 cm

Average Si for Layer - IA =	4.59 mm	Average Si for Layer - I =	2.85 mm
Total immediate settlement =	7.44 mm	(for both the layer)	

D) Calculation of Consolidation Settlement:

Strata	From (M)	To (M)	Thickness (M)	Mid depth (M)	Δ P (kg/sqcm)	m_{vc}, sqcm/kg	G	S_c (cm)
Layer - IA	2.50	4.39	1.89	0.94	0.56	0.0147	0.75	1.17
	4.39	6.27	1.89	2.83	0.39	0.0147	0.75	0.80
Layer - I	6.27	10.39	4.12	5.83	0.24	0.0100	0.70	0.69
	10.39	14.50	4.12	9.94	0.14	0.0100	0.70	0.42
Hence, Total Consolidation Settlement =								30.69 mm

So, Total Settlement =	38.14	mm
Fox's Depth correction Factor =	0.92	
Corrected total settlement =	**35.10**	**mm**

So, a net allowable bearing capacity of 07 T/m^2 can be used for limiting settlement of 40mm.

SAMPLE CALCULATION FOR BOILER & MILL BUNKER

Let us place the foundation at 1.00m below FGL (i.e. 375 M).

Founding level falls inside stratum -III.

This layer consists of complete weathered, decomposed and disintegrated rock.

Considering this as sand, use C = 0.00 kg/sqcm&Φ = 35° for bearing capacity calculation using C-Φ method.

CALCULATION OF NET SAFE BEARING CAPACITY:

The Net Ultimate Bearing Capacity is given as:

$$q_{nu} = C.N_c.S_c.D_c + q.N_q.S_q.D_q + 0.5\gamma.B.N_\gamma.S_\gamma.D_\gamma - q$$

Where,

N_c, N_q and N_γ are bearing capacity factors,
S_c, S_q and S_γ are shape factors,
D_c, D_q and D_γ are depth factors,

And

C = Cohesion
q = Overburden pressure,
B = Width of foundation,
γ = Effective density below foundation.

Size of Raft Foundation = 6m x 12m

Cohesion, C = 0.00 t/sqm

Using ϕ = 35 degree, the bearing capacity factors are:

N_c = 46.12
N_q = 33.30
N_γ = 48.03

Use,

Depth of Foundation = D_f = 1.0 M (below FGL)
Width of Foundation = B = 6.0 M
Length of Foundation = L = 12.0 M

Overburden Pressure = q =1.000 (Depth) x 0.90 (Submerged density) = 0.90 t/sqm (assuming the ground water table is flushing with the ground level)

The Shape factors are [IS:6403 - 1981]

S_c = 1.10 S_q = 1.10 S_γ = 0.80

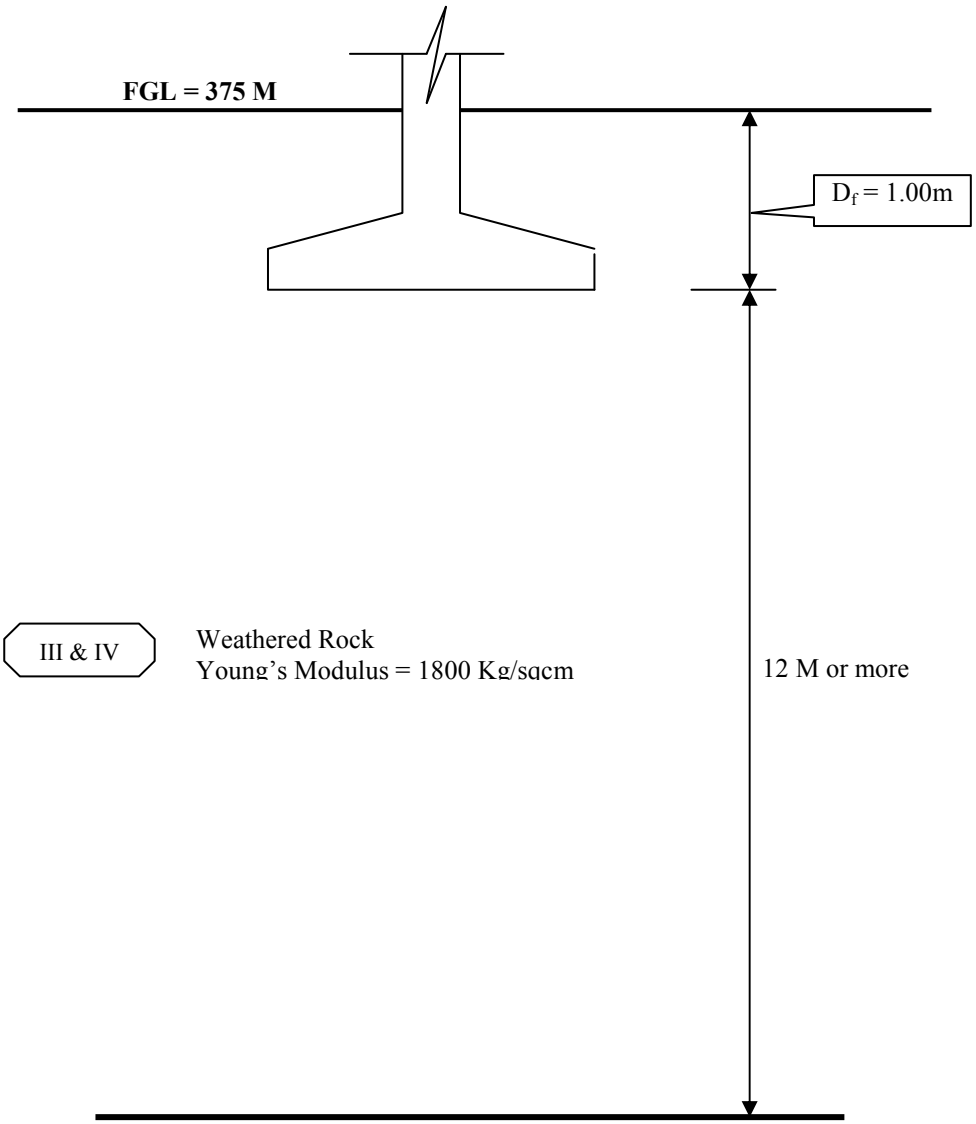
The Depth factors are [IS:6403 - 1981]

D_c = 1.06 D_q = 1.03 D_γ = 1.03

Computed Net Ultimate Bearing Capacity = 140.18 t/sqm

Using a factor of safety of 2.5, Net Safe Bearing Capacity = 56.07 t/sqm

The above bearing capacity should be checked against settlement criteria.



RAFT FOUNDATION DESIGN MODEL FOR BOILER & MILL BUNKER

Using design layer stratification

(Not to Scale)

SETTLEMENT CALCULATION:

With reference to the above, the settlement is calculated and presented below.

A) General Data:

Width of foundation =	6.0	m
Length of foundation =	12.0	m
Depth of foundation =	1.0	m
Net Base Pressure =	4.0	kg/sqcm

B) Subsoil Properties:

Rock Layer

Young's Modulus =	1800	kg/sqcm
Poisson Ratio, μ =	0.25	
Top of Stratum =	1.00	m
End of Stratum =	13.00	m
Geological factor, G =	1.00	
m_{vc} =	0.0000	sqcm/kg

C) Calculation of Immediate Settlement:

Settlement at center

M = L' / B' = 2.000

N = H / B' = 4.000

I_1 = 0.476

I_2 = 0.069

$I_s = I_1 + \{(1-2\mu) / (1-\mu)\} I_2$ = 0.522

Immediate settlement S_i = 1.305 cm

$[q_o \times B' \times (1- \mu^2) \times m \times I_s] / E_s$

Settlement at corner

M = L' / B' = 2.00

N = H / B' = 2.000

I_1 = 0.289087

I_2 = 0.102416

$I_s = I_1 + \{(1-2\mu) / (1-\mu)\} I_2$ = 0.357

Immediate settlement S_i = 0.447 cm

Average Si for Rock Layer 8.76 mm

Total immediate settlement = 8.76 mm

So, Total Settlement = 8.76 mm

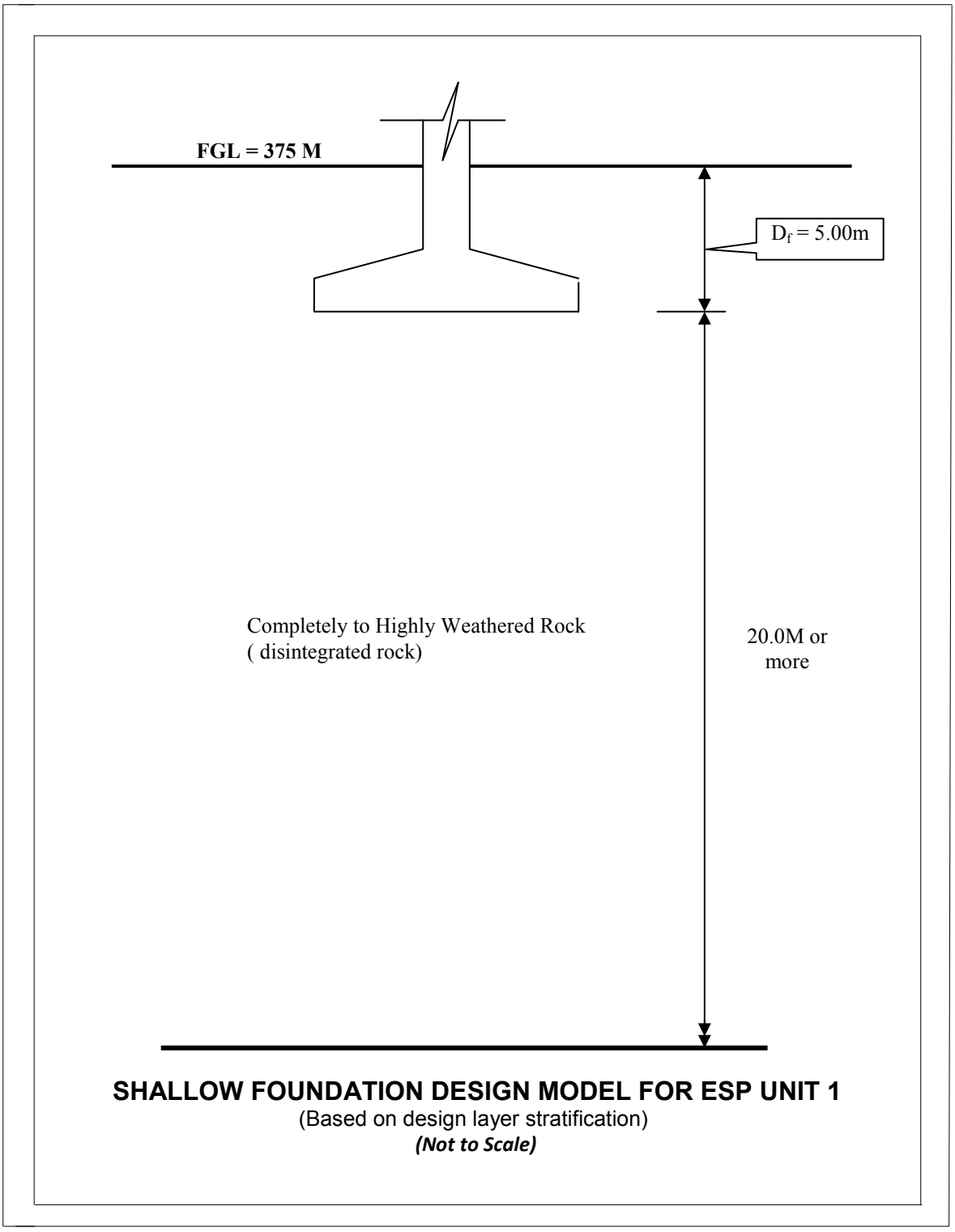
Fox's Depth correction Factor = 0.98

Corrected total settlement = 8.54 mm

So, use a net allowable bearing capacity of 40 T/m^2 for limiting settlement of 12mm.

SAMPLE CALCULATION FOR ESP UNIT 1

Considering the subsoil condition, let us place the foundation at 5.00m below F.G.L. (+375 M). Founding level falls inside stratum -III.



SHALLOW FOUNDATION DESIGN MODEL FOR ESP UNIT 1

(Based on design layer stratification)

(Not to Scale)

BEARING CAPACITY BASED ON RMR METHOD:

Based on the geological observation so found from rock core samples the bearing capacity is calculated as follows:

Calculated RMR = 22 as per IS: 13365(Part1)-1998, Annex B

g) The design value of point load strength index in layer III is taken as 1.93 kg/sqcm. Corresponding rating = 1
h) RQD value, a minimum of 10% is considered as per codal provision (IS 13365, Part 1), corresponding rating = 03
i) Spacing of discontinuity taken as very close. corresponding rating = 05
j) Condition of discontinuity [Refer "Support of Underground Excavations in Hard Rock" by E. Hoek, P.K. Kaiser & W.F. Bawden, Table 4.4: Rock Mass Rating System (After Bieniawski, 1989) attached at the end of this report]
   IV. Discontinuity length (persistence) taken as 1-3m, corresponding rating = 04
   V. Roughness considered as slightly rough, corresponding rating = 03
   VI. Weathering condition considered as highly weathered, corresponding rating = 01
k) Ground water condition taken as Wet. corresponding rating = 07
l) Dip Angle Joint Orientation taken as favourable (based on geological formation), corresponding rating = (-)2

So, RMR = 01+03+05+04+03+01+07+(-)2 = 22

So, from Table-3 of IS: 12070 (Amendment 1, Nov. 2008) q_{ns} = 52.58 t/sqm (by interpolation) for 12mm settlement.
However let us restrict the net allowable bearing capacity to 45 t/sqm for depth of foundation of 5.0m below FGL around ESP Unit 1.

SAMPLE CALCULATION FOR ACW COOLING TOWER (FOR BH-131)

Considering the subsoil condition, let us place the foundation at 4.00m below F.G.L. (+378 M).

Founding level falls inside stratum -IIA.

Use design cohesion, C = 0.00 kg/sqcm & Φ = 28°

CALCULATION OF NET SAFE BEARING CAPACITY:

The Net Ultimate Bearing Capacity is given as:

$$q_{nu} = C.N_c.S_c.D_c + q.N_q.S_q.D_q + 0.5\gamma.B.N_\gamma.S_\gamma.D_\gamma - q$$

Where,

N_c, N_q and N_γ are bearing capacity factors,
S_c, S_q and S_γ are shape factors,
D_c, D_q and D_γ are depth factors,

And

C = Cohesion
q = Overburden pressure,
B = Width of foundation,
γ = Effective density below foundation.

Size of Raft Foundation = 6m x 12m

Considering Local Shear Faliure:

Cohesion, C = 0.00 t/sqm
Using $\phi = 2/3 \times \phi` = 2/3 \times 28 = 19$ degree, the bearing capacity factors are:

$N_c = 13.93$
$N_q = 5.80$
$N_\gamma = 4.68$

Use,

Depth of Foundation = D_f = 4.00 M (below FGL)
Width of Foundation = B = 6.00 M
Length of Foundation = L = 12.0 M

Overburden Pressure = q =4.000 (Depth) x 0.90 (Submerged density) = 3.60 t/sqm (assuming the ground water table is flushing with the ground level)

The Shape factors are [IS:6403 - 1981]

$S_c = 1.10$ $S_q = 1.10$ $S_\gamma = 0.80$

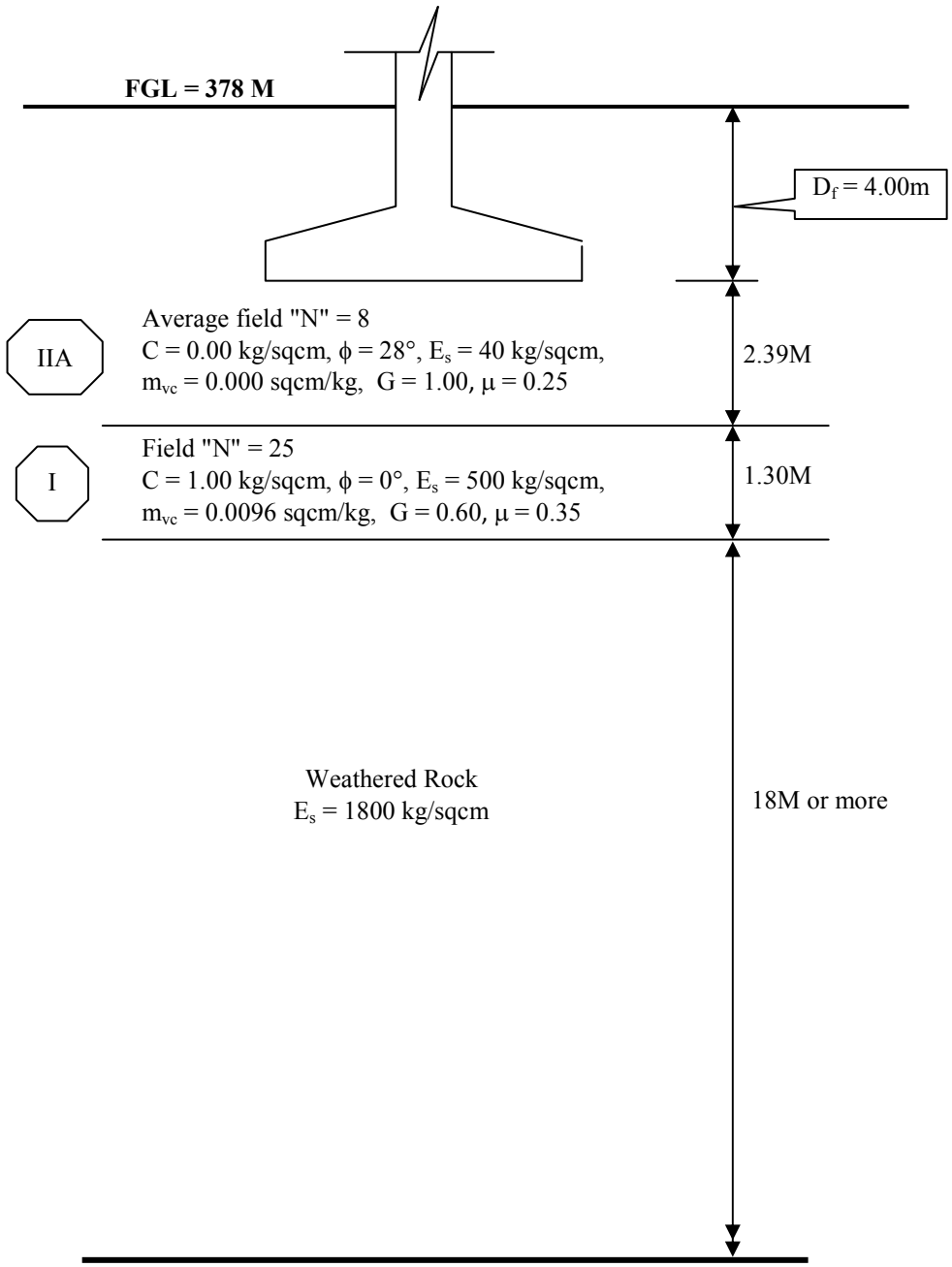
The Depth factors are [IS:6403 - 1981]

$D_c = 1.19$ $D_q = 1.09$ $D_\gamma = 1.09$

Computed Net Ultimate Bearing Capacity = 32.56 t/sqm

Using a factor of safety of 2.5, Net Safe Bearing Capacity = 13.02 t/sqm

The above bearing capacity should be checked against settlement criteria.



RAFT FOUNDATION DESIGN MODEL FOR ACW COOLING TOWER

(Based on design layer stratification around BH-131)

(Not to Scale)

SETTLEMENT CALCULATION:

With reference to the above, the settlement is calculated and presented below:

Settlement Analysis

A) General Data:

Width of foundation =	6.0	m
Length of foundation =	12.0	m
Depth of foundation =	4.0	m
Net Base Pressure =	1.3	kg/sqcm

B) Subsoil Properties:

Layer - IIA			Layer - I			Layer - III		
Young's Modulus =	40	kg/sqcm	Young's Modulus =	500	kg/sqcm	Young's Modulus =	1800	kg/sqcm
Poisson Ratio, μ =	0.25		Poisson Ratio, μ =	0.35		Poisson Ratio, μ =	0.25	
Top of Stratum =	4.00	m	Top of Stratum =	6.39	m	Top of Stratum =	7.69	m
End of Stratum =	6.39	m	End of Stratum =	7.69	m	End of Stratum =	16	m
Geological factor, G =	1.00		Geological factor, G =	0.60		Geological factor, G =	1	
m_{vc} =	0.0000	sqcm/kg	m_{vc} =	0.0096	sqcm/kg	m_{vc} =	0.0000	sqcm/kg

C) Calculation of Immediate Settlement:

Settlement at center

Layer - IIA		Layer - I		Layer - III	
M = L' / B' =	2.000	M = L' / B' =	1.715	M = L' / B' =	1.619
N = H / B' =	0.797	N = H / B' =	0.310	N = H / B' =	1.715
I_1 =	0.088	I_1 =	0.017	I_1 =	0.252
I_2 =	0.103	I_2 =	0.060	I_2 =	0.096
$I_s = I_1 + \{(1-2\mu)/(1-\mu)\} I_2$ =	0.157	$I_s = I_1 + \{(1-2\mu)/(1-\mu)\} I_2$ =	0.045	$I_s = I_1 + \{(1-2\mu)/(1-\mu)\} I_2$ =	0.316
Immediate settlement S_i =	5.746 cm	Immediate settlement S_i =	0.102 cm	Immediate settlement S_i =	0.197 cm
$[q_o \times B' \times (1-\mu^2) \times m \times I_s] / E_s$		$[q_o \times B' \times (1-\mu^2) \times m \times I_s] / E_s$		$[q_o \times B' \times (1-\mu^2) \times m \times I_s] / E_s$	

Settlement at corner

Layer - IIA		Layer - I		Layer - III	
M = L' / B' =	2.00	M = L' / B' =	1.72	M = L' / B' =	1.619
N = H / B' =	0.398	N = H / B' =	0.155	N = H / B' =	0.858
I_1 =	0.026299	I_1 =	0.004	I_1 =	0.103
I_2 =	0.072651	I_2 =	0.034	I_2 =	0.100
$I_s = I_1 + \{(1-2\mu)/(1-\mu)\} I_2$ =	0.075	$I_s = I_1 + \{(1-2\mu)/(1-\mu)\} I_2$ =	0.020	$I_s = I_1 + \{(1-2\mu)/(1-\mu)\} I_2$ =	0.170
Immediate settlement S_i =	1.366 cm	Immediate settlement S_i =	0.023 cm	Immediate settlement S_i =	0.053 cm

Average Si for Layer - IIA =	35.56 mm	Average Si for Layer - I =	0.63 mm	Average Si for Layer - III =	1.25 mm
Total immediate settlement =	37.43 mm	(for all the three layers)			

D) Calculation of Consolidation Settlement:

Strata	From (M)	To (M)	Thickness (M)	Mid depth (M)	ΔP (kg/sqcm)	m_{vc}, sqcm/kg	G	S_c (cm)
Layer - I	6.39	7.04	0.65	2.72	0.73	0.0096	0.60	0.27
	7.04	7.69	0.65	3.37	0.65	0.0096	0.60	0.24
Hence, Total Consolidation Settlement =								5.17 mm

So, Total Settlement =	42.60	mm
Fox's Depth correction Factor =	0.86	
Corrected total settlement =	**36.55**	**mm**

So, a net allowable bearing capacity of 13 T/m^2 can be used for limiting settlement of 75mm.

7. GEOLOGICAL REPORT

LOCATION

500 km
Delhi
Patna
Kolkata
Mumbai
Chennai

JHARKHAND
BIHAR
UTTAR PRADESH
WEST BENGAL
CHHATTISGARH
ODISHA (ORISSA)
RANCHI
Sahibganj
Godda
Pakaur
Maheshpur
Dumka
Deoghar
Jamtara
Dhanbad
Bokaro
Chas
Ramgarh
Hazaribag
Chatra
Latehar
Garhwa
Palamu
Daltonganj
Kodarma
Giridih
Bermo
Gumla
Khunti
Simdega
Chaibasa
Jagannathpur
Saraikela
Kharsawan
Jamshedpur
Chakradharpur
Ghatshila
LEGEND
International Boundary
State Boundary
District Boundary
National Highway
Major Road
Railway
State Capital
District HQ.
Major Town
Map not to Scale
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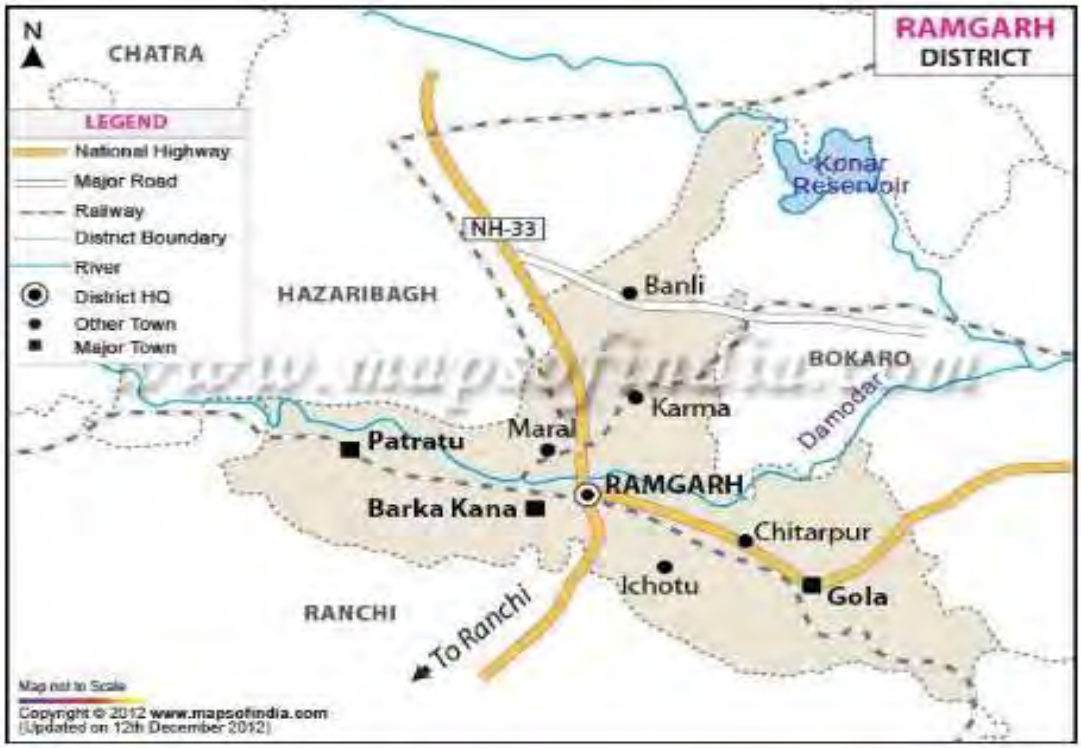
N
CHATRA
RAMGARH
DISTRICT
LEGEND
National Highway
Major Road
Railway
District Boundary
River
District HQ
Other Town
Major Town
Konar Reservoir
NH-33
HAZARIBAGH
Banli
BOKARO
Karma
Damodar
Maral
Patratu
RAMGARH
Barka Kana
Chitarpur
Ichotu
Gola
RANCHI
To Ranchi
Map not to Scale
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(Updated on 12th December 2012)

7.1. INTRODUCTION:

The Geo-technical Investigations have been carried out for the proposed construction of 3x800 MW Super Thermal Power Plant located at Patratu village in the District Ramgarh, Jharkhand. Physio-graphically the 'area of interest' lies in the Ramgarh district and is located about 30km west from Ramgarh, the nearest well known district town. Accessible National and State Highways are also available from Ranchi, the State Capital and the site is well connected by metalled road which ultimately connected the major road of the state. Nearest railway station is Patratu, 04 km from the site. Another nearest railway link is Ranchi railway Station 43 km from the site. Geologically the area belongs to the Precambrian basement rock of Chotonagpur granite gneissic complex (Figure 1) and at places Lower Gondwana is overlies the earlier one. Geo-morphologically the area is more or less plain land with shallow highs and lows. Most part of the area is barren with scatteredly distributed seasonal bushes and various types of forest tree. The entire area is covered with soil of variable thickness. To understand the in-situ sub-surface condition, a detailed investigation works have been carried out both by Boring (in soil by Shell and Auger) and followed by Drilling & Coring (in case of rock by Rotary Diamond Drilling) methods during the periods of February – May 2018. Total 194 numbers of boring followed by drilling have been done in the main plant area. The boreholes are systematically distributed over the area as per requirement for the project. The maximum and minimum depth of investigation has been restricted between 10m to 30m depending on the proposed structures. It has been observed that the rock strata encountered by drilling below the soil varies from about 0.0M to about 16.00m depth.

7.2. REGIONAL GEOLOGY AND STRATIGRAPHY:

Chotonagpur Granite Gneiss Complex (CGGC) is an ENE–WSW trending high-grade terrain in the eastern part of Central Indian Tectonic Zone (CITZ) and covers an area of about 80,000 km^2. It is bordered by the Singhbhum mobile belt in the south, the Quaternary Gangetic alluvium in the north and by the Rajmahal basalt in the northeast. In the west, CGGC is separated from CITZ by younger Gondwana sediments. The terrain consists of mostly gneisses and migmatites with numerous meta-sedimentary enclaves of varying metamorphic grade which are in turn intruded by metabasic, anorthositic and granitic plutons and major parallel shear zones with a strike extension of about 500 km and a width of 200 km in E–W direction. Younger mafic, ultramafic and alkaline (sodic and ultrapotassic) intrusives of early Tertiary age are also present (Dunn 1929; Ghose 1983, 1992; Mahadevan 2002; Mazumdar 1988; Sarkar 1988). The rocks of CGGC are complexly deformed and metamorphosed showing varying degrees of metamorphism, exhibiting

mainly amphibolite facies but ranges from greenschist (mostly in SE part of CGGC) to granulite facies (central and eastern parts of CGGC) (Bhattacharya 1976; Banerji 1991; Mahadevan 2002; Sharma 2009).

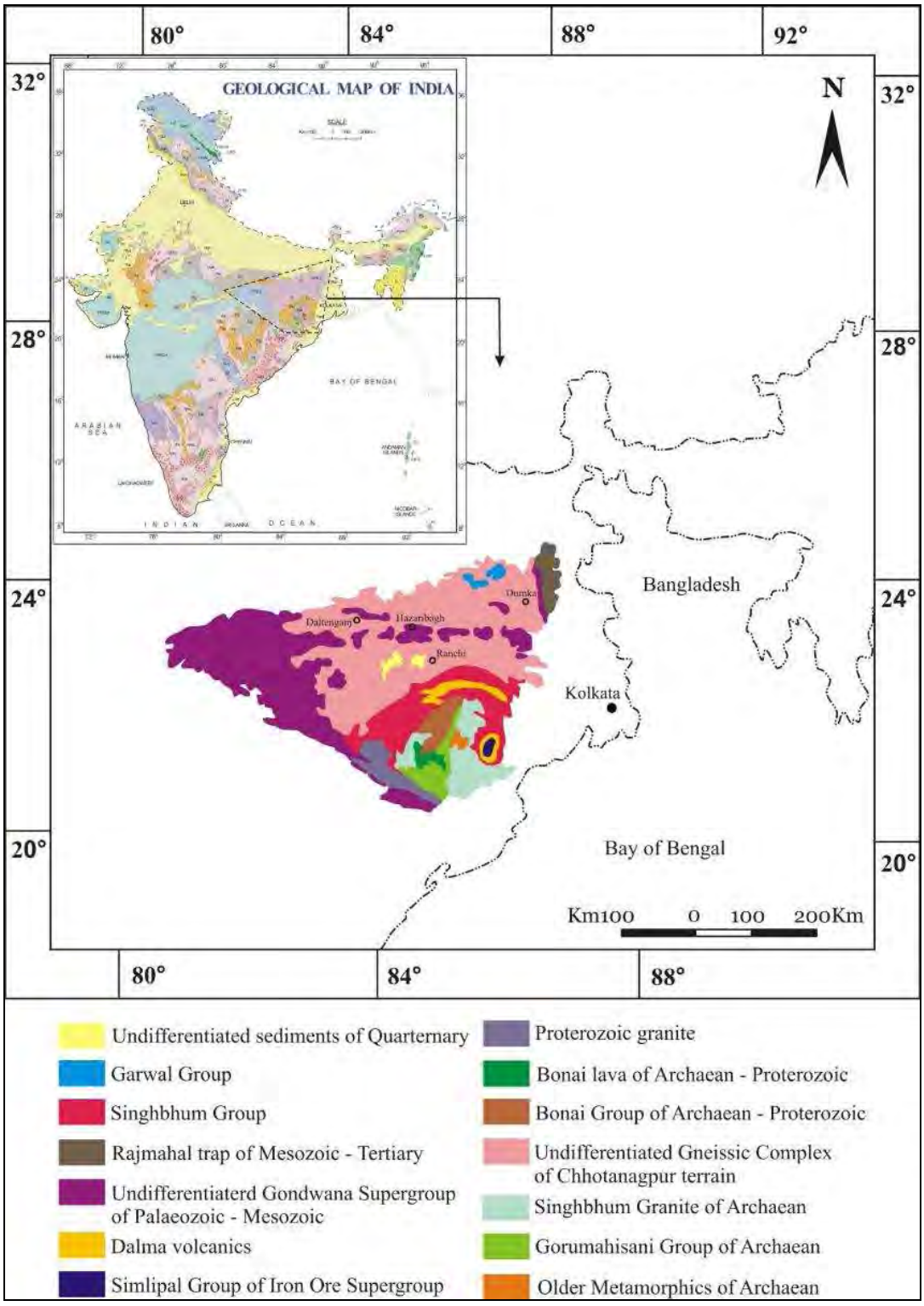

Figure.1: Generalized geological map of JHarkhand prepared by the G S I (2006).

Table. 1: General stratigraphy of Gondwana sediment

	Recent deposit of alluvium and laterite			
Post Gondwana	*Rajmahal Traps:*		*Dyke of basic igneous rocks* *Dyke of basic and Ultra basic Igneous rock*	*Cretaceous – Eocene* *Triassic - Jurassic*
Gondwana Sequence	*Upper*		*Dubarajpur formation*	*Upper Triassic – Middle Jurassic*
			Supra Panchet (Mahadeva Fm) *..... Unconformity .....* *Panchet Formation*	*Upper Triassic* *Middle Triassic* *Lower Triassic*
	Lower	*Damuda Group*	*Ranigunj Formation.* *Kulti Formation (Barren Measures).* *Barakar Formation* *Karharbari Formation (basal member of Barakar Fm)*	*Upper Permian* *Middle Permian* *Lower Permian* *Lower Permian*
			Talchir Formation including glacier boulder bed.	*Upper carboniferous to Lower Permian*
	Archaean gneisses and schist or rock of Proterozoic age			

Table. 2: Stratigraphic succession of the Chhotanagpur Granite Gneiss Complex (after Ghose, 1992).

Stratigraphic Age	***Description***
Mesozoic *Late intrusive*	*Rajmahal* *Lamprophyre* *Dolerite*
Palaeozoic	*Hornblende lherzolite Aphanitic quartz aplite Alkali syenite porphyry* *Syenite, nepheline syenite and riebeckite granite*
Syn- to post tectonic granitoids Meso- to neo- proterozoic	*Pegmatite, quartz & feldspar veins* *Porphyritic granite* *Pink granite & grey granite* *Diorite, quartz diorite, tonalite and granodiorite* *Granulite and charnockite (Phase II)*
Syn-tectonic basic intrusive Late Plaeo-to Proterozoic	*Massif Anorthite (Bengal)* *Meta-pyroxenite, norite, pyroxene, granulites, coronite olivine, gabbro, Coronite, two pyroxene gabbro, gabbro Metadolerite, amphibolite, anorthosite*
Pre-tectonic mafic-ultrmafic intrusive Palaeo-proterozoic to Late Archaean	*Amphibolite (schistose) Meta-ultramafic (viz., talc-remolite schist, tremolite-actinolite schist, chlorite schist,actinolite-cummingtonite schist, hornblende schist, serpentinite) and layered anorthosite*
Basement Archaean (?)	Tonalite gneiss,volcanoclastic metasediments, khondalite and leptynite (Granulite facies, phase I)

7.3. STRUCTURE AND TECTONICS:

The Chotonagpur Granite Gneissic Complex (CGGC) is considered here as a cratonic region whose convergence with the Singhbhum craton to the south gave rise to the Singhbhum mobile belt. It extends in the E-W across the states of Chattisgarh, Jharkhand, Orissa and West Bengal. The Chhotanagpur Granite-Gneiss Complex (CGGC) is bordered on the north by Gangetic alluvium, on the south by Singhbhum mobile belt and on the northeast by the Rajmahal basalt. Mahadevan compiled a geological map (Mahadevan, 2002) and divided the CGGC into five major divisions or belts (Figure. 2), based on broad lithological ensemble. These east-west trending metamorphic belts from S to N are as follows:

I. **South Palamau-Gumla-Ranchi-Purulia Belt:** Shows a progressive change from greenschist facies in the south, through amphibolites facies to granulite facies near Adra and beyond.
II. **Daltonganj-(North Palamau)-Hazaribagh Belt:** Exposes high-grade rocks, particularly granulites that occurred interbanded with granites and gneisses and form concordant bands with metasediments.
III. **North Garhwa-Chatra-Girdih- Deogarh-Dumka Belt:** Contains isolated pockets of granulite facies rocks, occurring within felsic gneisses.
IV. **The Bihar Mica Belt:** The Bihar Mica Belt (BMB) is a sequence of arenaceous and pelitic rocks, interbanded with hornblende schists or amphibolites.
V. **Rajgir-Munger Belt:** These rocks have been intruded by large granitic bodies followed by younger basic dykes.

The Singhbhum orogenic belt and its early mesoscopic folds have E-W trend, it is implied that N-S compressive forces must have been generated by N-S collision of the Singhbhum (Orissa) craton against a crustal block to the north, which seems to be none other than the Precambrian massif of CGGC lying just north of the Archaean craton of Singhbhum. Northward subduction of the Singhbhum (Orissa) craton under the northern block requires collision with the CGGC in all evolutionary models of Singhbhum fold belt. In this process the subduction and collision resulted into thickening of the crust that must have generated granitic melt (by partial melting), emplaced as granite intrusions in the overriding plate. This overriding plate was most likely the CGGC, which shows several granitic intrusions and high-grade rocks, all showing resetting of isotopic ages. Although unproven geochronologically, the CGGC should have been a Precambrian crustal block that needed to collide with the Singhbhum (Orissa) craton in the south to develop the Singhbhum fold belt during Proterozoic.

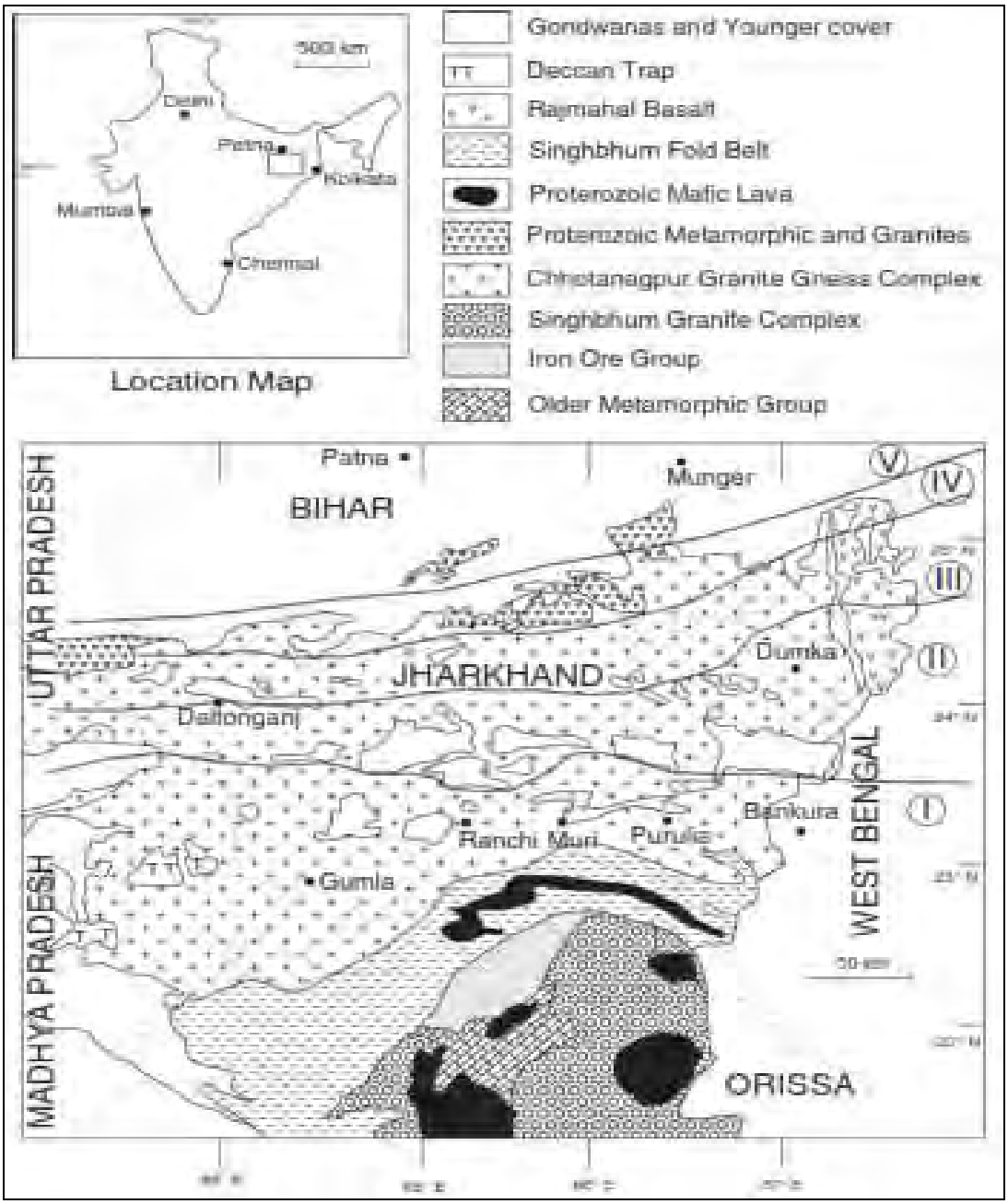

Figure. 2: Location and distribution of Chhotanagpur Granite Gneiss Complex (CGGC). The five geological belts (I–V) outlined by zigzag line in the CGGC terrain are drawn after Mahadevan (2002). Dotted lines are boundaries of the States.

7.4. THE STUDY AREA:

The proposed area around Patratu belongs to the Chotonagpur Granite Gneiss Complex (CGGC), more precisely in South Palamau-Gumla-Ranchi-Purulia Belt (by Mahadevan, 2002). The area represents a high-grade granulites belt in many respects similar to well known granulites belt of Peninsular India. The occurrences of Lower Gondwana sediments also have been reported from the study area. It was observed that Sandstone / Shale rocks of Lower Gondwana overlies Chotonagpur Gneissic complex. Rocks were deposited for a large span of time from Upper Carboniferous to the Jurassic or Middle Cretaceous along definite tracts mainly confined in Peninsular India. These huge pile of sediments known rocks as Gondwana sequences are developed in number of isolated outcrops and are stretches from Rajmahal hills in Bengal to the Madras. The entire sequence is composed of un-metamorphosed sandstone and shale. The rock types encountered within the study area are furnished below.

7.4.1. GENERAL DESCRIPTION OF ENCOUNTERED ROCKS:

Granite gneisses: One of the frequent rock types of the area is the Granite gneiss. The alternate bands are rich in felsic components and mafic components. These are medium grained rocks with quartz and feldspar (both plagioclase and k-feldspar) as dominant constituents. Biotite, garnet, sphene. This unit is dominantly banded gneiss with alternate bands rich in felsic components and mafic components. The bands rich in felsic minerals are greyish pink colored and the bands rich in mafic minerals are only slightly darker than the felsic bands, but also light in color. Graines are interlocked and compacted. Due to presence of some megacrystals of feldspar the rock show porphyritic texture and hence it is porphyritic granite gneiss. The banded gneisses preferably split along or parallel to the high angle gneissosity of the rock (dip of the gneissosity is 55°-70°). The rock is hard and strong with medium to slightly high specific gravity and has very low porosity. Depending on the weathering intensity the light pinkish body color of the rock has great affected and the color change to yellowish brown to greyish brown, sometimes dark colored. In most of the bore holes core recovery and RQD % are low is due to presence of random, closely spaced fractured and rapid variation of the grain sizes and prolonged weathering affects along the weak sheared plains. However, with depth quality of rock improved rapidly. Most of the joints / fractures are continuous. It is noted that the horizontal fractured surfaces are discontinuous, non-planar and rough. Whereas vertical to sub-vertical and inclined open fractured surfaces are mostly planar, relatively smooth to smooth and stain within the weathering depth. The strength property of the rock reduced greatly due to weathering.

Granite schist and Quartz-biotite-schist also encountered in few bore holes.

Hornblende schist and gneisses: Depending on the intensity of weathering the body color of the rock as a whole varies from yellowish brown to brownish grey at the weathering end and greenish grey to dark greyish black for the fresh variety of rock. The rock is dominantly medium to fine grained. Grains are equigranular and are interlocked. With parallel arrangement of the hornblende mineral, the rock imparts well foliated schistose structure and become extreme fissile in nature and changes to hornblende schist or simply schist. With the alteration of mafic-felsic bands of layers of mafic minerals the rock posse's gneissic structure. However, schistose and gneissic structures have high inclination (varies from 50° to as high as almost 80°). In general the schist is moderately hard, moderately packed and moderately strong to strong across the foliation / schistosity (at fresh end). Schist has relatively high specific gravity than the gneissic rock. Depending on weathering the both rocks become porous and the strength parameters reduced a great extent. Under the soil cover the gneiss / schist is complete to highly weathered and the core recovery is low to very low. However, core recovery and rock quality both is improved with depths. Due to distinct foliation plains the rocks are easily split along such weak plains. The open surfaces are dominantly planar, smooth and stain to clean depending on intensity of weathering.

Sandstone: Sandstone is also a common rock type encountered within the area of interest. It is essentially composed of quartz with decomposed and altered feldspar and mica as minor constituents; rare dark minerals are not uncommon. Depending on the intensity of weathering the body color of the rock varies from yellowish brown to reddish brown though light greenish grey to light grey / dark grey colors are varies from weathered to fresh variety sandstone. The rock is dominantly fine to medium grained, some are very fine; apparently massive and medium spaced bedded. Sometimes thick to moderately thick beds are very thinly inter banded and a few instances shows sets of cross bedding with low angle stratification (dominantly <10°-15° inclination). Grains are mostly sub rounded-to-rounded. Frequently the sandstone contains extremely fine-grained shale clasts of variable sizes and also stringers and layers of it. The orientation of such clasts is dominantly bed parallel. A general trend of fining -up sequence is observed. In general the sandstone is matrix supported, moderately to medium hard, moderately strong (at fresh end), medium to tightly compacted and moderately porous with medium low specific gravity. Depending on weathering the strength parameters also reduced a great extent.

Shale: The color of the shale varies depending on degree of weathering though remains light grey to greyish black / blackish grey. Grain size of the rock varies from extremely fine to fine grains. At the intensively weathering end the body color of the shale varies from brownish yellow to yellowish brown and sometimes light grey whereas fresh shale is dominantly greyish black to dark blackish grey. It is very thinly laminated but not cleaved. The shale frequently contains stringers of sand / silt and less frequently clasts of sandstone / siltstone. Mineralogical composition of shale is not identified due to its extreme fine (shale) nature. The rock is soft, densely compacted and depending on degree of weathering it may be weak, usually strong to very strong. Preferably and easily split along the almost horizontal to very low angle (<5°) lamination planes. Weathered shale easily breaks under finger pressure or even disintegrates into rock particles when kept in water and at dry conditions the surface of the shale is marked with sun-cracks. Compositionally shale is homogeneous and structurally isotropic but intervention with silt / sand is dominant at some depths. Porosity of the shale is very low and the specific gravity is medium.

Coal: Coal has been found within sandstone as stringers / laths or thin bands. However, greater than 1m thick coal bed also present in few bore holes banded with generally carbonaceous shale and in rare occasion with sandstone. Coal is dark black color with characteristic shining and is composed of fine macerals. It is conchoidally fractured.

Detailed geological logging of each Boreholes are furnished below

7.5. SEISMISITY:

According to the seismic map of India the area of interest fall in Zone - II as per IS 1893 – 2002 and correspond to an earthquake intensity of VI, as per modified Meracalli Intensity scale (MSK). Zone factor 0.10 should be used in design of structure. The information is intended to bring out the fact that the site shall be considered to lies on tectonically low risk zone. Hence, suitable seismic coefficient commensurate to seismic zone-II and Important factor (I=1.0 or 1.5, depending on the type of structure) shall be adopted in the design of the structures.

For C. E. Testing Company private Limited,

(Mr. D. Acharyya, Geologist) **(Mr. S. Paramanik, Geologist)**

GEOLOGICAL LOGGING

BH : 01

(00.00 – 07.00)m: Overburden.

(07.00 – 15.00)m: **Rock Description**: Highly weathered, yellowish grey, fine grains are loose to moderately compact, **Sandstone interbedded with Shale**.
Rock Properties: Medium soft to moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m). Dominantly horizontal fractures. Few inclined fractures (62^0 dip at 10.75-11.50m depth) are also observed. Open fracture surfaces are planar, slightly rough to smooth and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm with few 100-200mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 02

(00.00 – 05.75)m: Overburden.

(05.75 – 10.00)m: **Rock Description**: Highly weathered, yellowish grey, fine grains are loose compact, **Interbedded sequence of Sandstone and Shale**.
Rock Properties: Soft and weak rock.

Structural Condition: Very closely spaced (>15 nos./m). Dominantly horizontal fractures. Open fracture surfaces are planar, smooth and slightly altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 03

(00.00 – 01.50)m: Overburden.

(01.50 – 15.00)m: **Rock Description**: Moderately weathered, light brownish grey, medium grains are loose to moderately compact, **Sandstone**.
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m) with pockets of closely spaced (15-8 nos/m, 9.00-12.00m). Dominantly horizontal fractures. Few inclined fractures (65^0 dip at 14.25-15.00m depths) are also observed. Open fracture surfaces are planar, slightly rough and slightly altered.

Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm and 100-200mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderately weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 04

(00.00 – 10.00)m: **Rock Description**: Slightly weathered, light brownish grey, coarse grains are loosely compact (upto 08.25m) followed by slightly weathered, light grey, fine grains are moderately compact **Sandstone**.
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m). Dominantly horizontal with vertical fracture observed (at 9.00-10.00m depth). Open fracture surfaces are planar, slightly rough and slightly altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm and rarely 100-200mm (8.25-9.00m).
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 05

(00.00 – 06.00)m: Overburden.
(06.00 – 15.00)m: **Rock Description**: Slightly weathered, light brownish grey to light grey, coarse grains are loosely compact, fine grains are moderately compact **Sandstone**.
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m). Dominantly horizontal with vertical fracture observed at places. Open fracture surfaces are planar, slightly rough and slightly altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm and rarely 100-200mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is slightly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 06

(00.00 – 02.80)m: Overburden.

(02.80 – 10.00)m: **Rock Description**: Moderately weathered, yellowish grey, medium to fine grains are moderately compact **Sandstone** interbedded with **Shale.**
Rock Properties: Moderately hard and medium weak to moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m). Dominantly horizontal. Open fracture surfaces are planar, smooth and slightly altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 07

(00.00 – 03.00)m: Overburden.

(03.00 – 15.00)m: **Rock Description**: Moderately weathered, yellowish brown, medium to coarse grains are loose to moderately compact **Sandstone**.
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m). Dominantly horizontal fracture. Open fracture surfaces are planar, slightly rough to smooth and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm and rarely 100-200mm at places.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 08

(00.00 – 02.75)m: Overburden.

(02.75 – 10.00)m: **Rock Description**: Moderately weathered, yellowish brown, medium to coarse grains are loose to moderately compact **Sandstone**.
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m). Dominantly horizontal fracture. Open fracture surfaces are planar, slightly rough to smooth and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm and rarely 100-

200mm at 14.00-15.00m.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 09

(00.00 – 04.00)m: Overburden.

(04.00 – 15.00)m: **Rock Description**: Moderate to slightly weathered, yellowish grey, coarse grains are loosely compact (upto 11.60m) followed by slightly weathered, light grey, fine grains are moderately compact **Sandstone**.
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m). Dominantly horizontal with pockets of vertical fracture observed (at 7.00-7.75m, 10.75-11.50m depth). Open fracture surfaces are planar, slightly rough (up to 11.60m) to smooth and slightly altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm and rarely 100-200mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderate to slightly weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 10

(00.00 – 03.20)m: Overburden.

(03.20 – 10.00)m: **Rock Description**: Moderately weathered, blackish grey, very fine grains are moderately compact **Shale** with coal streaks.
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m). Dominantly horizontal fracture. Open fracture surfaces are planar, smooth and slightly altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 11

(00.00 – 03.80)m: Overburden.

(03.80 – 30.00)m: **(03.80-15.75)m:**

Rock Description: Highly weathered, yellowish brown (up to 9.00m) then blackish grey, very fine grains are moderately compact, **Shale**.
Rock Properties: Soft and weak rock.
(15.75-30.00)m:
Rock Description: Slightly weathered, light grey, bedded, medium to fine grains are loosely compact, **Sandstone interlayered with Shale**.
Rock Properties: Medium soft and medium weak to moderately strong rock.

Structural Condition: Very closely spaced (15-8 nos./m). Dominantly horizontal fractures. Open fracture surfaces are planar, rough to smooth and altered (up to 15.00m) then slightly altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm and few 100-200mm pieces at place.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly to slightly weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 12

(00.00 – 05.25)m: Overburden.

(05.25 – 25.00)m: **(05.25-14.25)m:**

Rock Description: Highly weathered, brownish grey, very fine grains are moderately compacted, **Shale**.
Rock Properties: Soft and weak rock.
(14.25-25.00)m:
Rock Description: Highly weathered, blackish grey, bedded, fine grains are moderately compact, **Carbonaceous Shale and Coal**.
Rock Properties: Medium soft and medium weak rock.

Structural Condition: Very closely spaced (>15 nos./m). Dominantly horizontal with vertical fractures (at 16.50-17.25m, 18.00-18.75m). Open fracture surfaces are planar, smooth and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor to poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly to slightly weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 13

(00.00 – 16.00)m: Overburden.

(16.00 – 18.25)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge.

(18.25 – 30.00)m: **Rock Description**: Moderate to slightly weathered, blackish grey, fine grains are moderately compact, **Shale interlayered with Sandstone and coal streaks**.
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Closely spaced (15-8 nos./m). Dominantly horizontal with inclined fractures (55^0 dip at 19.00-19.75m, 60^0 dip at 22.00-22.75m, 60^0 dip at 25.50-26.25m, 63^0 dip at 26.50-27.25m depths) are also observed. Open fracture surfaces are planar, slightly rough to smooth and slightly altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm and 100-200mm with rare 100-300mm pieces at place.
Rock Mass Structure: The rock mass is very poor to poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderate to slightly weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 14

(00.00 – 02.50)m: Overburden.

(02.50 – 03.25)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge.

(03.25 – 25.00)m: **Rock Description**: Moderate to slightly weathered, blackish grey, fine grains are moderately compact, **Shale interlayered with Sandstone and coal streaks**.
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Closely spaced (15-8 nos./m). Dominantly horizontal with locally inclined fractures (55^0 - 60^0 dip) are also observed. Open fracture surfaces are planar, slightly rough to smooth and slightly altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm and 100-200mm pieces.
Rock Mass Structure: The rock mass is very poor to poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderate to slightly weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 15

(00.00 – 09.70)m: Overburden.

(09.70 – 30.00)m: **Rock Description**: Slightly weathered, alternative colour of light grey and dark grey, medium to fine grains are moderately compact, interbedded sequence of **Sandstone** and **Shale**.
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (upto 18.20m, >15 nos./m) followed by closely spaced (8-5 nos/m). Dominantly horizontal fractures. Few inclined fractures (48^0 dip at 15.75-16.50m, 63^0 dip at 16.50-17.25m, 68^0 dip at 17.25-18.00m, 46^0 dip at 20.25-21.00m, 48^0 dip at 24.75-25.50m depths) are also observed. Open fracture surfaces are planar, slightly rough to smooth and slightly altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm and 100-200mm with rare 100-300mm pieces at place.
Rock Mass Structure: The rock mass is very poor with locally poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is slightly weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 16

(00.00 – 11.50)m: Overburden.

(11.50 – 30.00)m: **(11.50-22.15)m:**
Rock Description: Highly weathered, zed black colour, **Carbonaceous Shale and Coal**.
Rock Properties: Moderately hard and moderately strong rock.
(22.15-30.00)m:
Rock Description: Moderately weathered, light grey, bedded, coarse grains are loosely compact, **Sandstone**.
Rock Properties: Moderately soft and moderately weak to moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m). Dominantly horizontal fractures. Open fracture surfaces are planar, rough to smooth and slightly altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm and few 100-200mm pieces at place.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly to moderately weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 17

(00.00 – 03.50)m: Overburden.
(03.50 – 04.25)m: Completely weathered, decomposed and disintegrated rock particles
(05.00 – 05.75)m: collected as sludge.
(07.25 – 10.25)m:
(04.25 – 30.00)m:

(04.25-10.25)m:
Rock Description: Highly weathered, light grey, very fine grained, moderately compacted, **Shale.**
Rock Properties: Moderately hard and moderately strong rock.
(10.25-24.60)m:
Rock Description: Moderately weathered, zed black colour, very fine grains are moderately compact, **Carbonaceous Shale and Coal**.
Rock Properties: Medium soft and medium weak to moderately strong rock.
(24.60-30.00)m:
Rock Description: Slightly weathered, greyish white, medium grains are moderately compact, **Sandstone**.
Rock Properties: Moderately hard and moderately strong rock.
Structural Condition: Very closely spaced (>15 nos./m). Dominantly horizontal with inclined fractures (68^0 dip at 13.25-14.00m). Open fracture surfaces are planar, rough to smooth and slightly altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm and few 100-200mm pieces at place.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly to slightly weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 18

(00.00 – 02.50)m: Overburden.
(02.50 – 25.00)m:

(02.50-21.25)m:
Rock Description: Moderately weathered, brownish grey (up to 16.75m) then slightly weathered, light grey, medium to fine grained, moderately compacted, **Sandstone.**
Rock Properties: Moderately hard and moderately strong rock.
(21.25-25.00)m:
Rock Description: Moderately weathered, greyish black colour **Carbonaceous Shale and Coal**.
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m). Dominantly horizontal with locally inclined fractures. Open fracture surfaces are planar, smooth and slightly altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm and few 100-200mm pieces at place.
Rock Mass Structure: The rock mass is very poor with locally poor

quality.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderately weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 19

(00.00 – 03.70)m: Overburden.

(03.70 – 30.00)m: **Rock Description**: Highly weathered, brownish grey, medium bedded, fine to medium grains are moderately compact **Sandstone** with locally interlayered with Shale.
Rock Properties: Moderately soft and weak rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fractures. Open fracture surfaces are planar, smooth and altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 20

(00.00 – 01.90)m: Overburden.

(01.90 – 02.50)m: Completely weathered, decomposed and disintegrated rock particles

(10.00 – 11.50)m: collected as sludge.

(02.50 – 30.00)m: **(02.50-11.55)m:**
Rock Description: Slightly weathered, brownish grey, fine grained, moderately compacted, **Sandstone.**
Rock Properties: Moderately hard and moderately strong rock.
(11.55-25.00, 26.40-27.25)m:
Rock Description: Zed black colour **Coal**.
Rock Properties: Moderately hard and moderately strong rock.
(25.00-30.00)m:
Rock Description: Slightly weathered, light grey, very fine grains are moderately compact, **Shale**.
Rock Properties: Moderately hard and moderately strong rock.
Structural Condition: Very closely spaced (>15 nos./m) with pockets of closely spaced (15-8 nos/m at 15.25-16.75m, 19.00-20.50m). Dominantly horizontal with inclined fractures (75^0 dip at 25.00-25.75m). Open fracture surfaces are planar, smooth and slightly altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm and few 100-200mm pieces at place.

Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderate to slightly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 21

(00.00 – 03.50)m: Overburden.

(03.50 – 25.00)m: **(03.50-10.25)m:**
Rock Description: Moderately weathered, reddish brown (up to 7.30m) then light grey, fine grained, moderately compacted, **Sandstone.**
Rock Properties: Moderately hard and moderately strong rock.
(10.25-25.00m:
Rock Description: Slightly weathered, blackish grey, very fine grained, moderately compacted, **Carbonaceous Shale and coal.**

Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m). Dominantly horizontal fractures. Open fracture surfaces are planar, slightly rough to smooth and slightly altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm and few 100-200mm pieces at place.
Rock Mass Structure: The rock mass is very poor.

Partial (up to 09.50m) then medium drill water loss has been noticed for the entire depth.
The formation rock is moderate to slightly weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 22

(00.00 – 04.50)m: Overburden.
(04.50 – 08.25)m: Completely weathered, decomposed and disintegrated rock particles
(11.25 – 12.75)m: collected as sludge.
(15.75 – 18.00)m:

(07.50 – 30.00)m: **Rock Description**: Highly to slightly weathered, brownish grey to blackish grey, fine to very fine grained, loose to moderately compacted, **Interbedded sequence of Sandstone and Shale.**
Rock Properties: Soft and weak to moderately hard and moderately strong rock.
With pockets of zed black colour **Coal** at 19.50-21.00m and 27.00-30.00m depth.
Structural Condition: Very closely spaced (>15 nos./m). Dominantly horizontal with inclined fractures (65^0 dip at 24.75-25.55m, 60^0 dip at 21.75-22.50m). Open fracture surfaces are planar, slightly rough and

slightly altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm and few 100-200mm pieces at place.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly to slightly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 23

(00.00 – 03.50)m: Overburden.

(03.50 – 25.00)m: **Rock Description**: Highly weathered, reddish brown, fine grained (upto 5.00m) followed by moderate to slightly weathered, light brownish grey, coarse grained, loose to moderately compacted, **Sandstone.**
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (up to 21.60m, >15 nos./m) followed by closely spaced (15-8 nos/m). Dominantly horizontal with inclined fractures (65^0 dip at 4.25-5.00m, 44^0 dip at 7.25-8.00m, 51^0 dip at 9.50-10.25m, 43^0 dip at 11.00-11.75m, 50^0 dip at 12.50-13.25m, 44^0 dip at 17.25-18.00m). Open fracture surfaces are planar, slightly rough and slightly altered.
Description of Core: Recovered core occurs as Discontinuous (up to 5.00m) followed by continuous framework. Cores are mostly in lengths of 30-100mm and few 100-200mm pieces at place.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly to slightly weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 24

(00.00 – 03.25)m: Overburden.

(03.25 – 05.50)m: Completely weathered, decomposed and disintegrated rock particles

(12.25 – 14.50)m: collected as sludge.

(15.25 – 16.00)m:

(05.50 – 25.00)m: **(05.50 – 12.25)m:**
Rock Description: Slightly weathered, yellowish grey, medium to coarse grained loosely compacted, **Sandstone.**
Rock Properties: Moderately hard and moderately strong rock.
(12.25 – 25.00)m:
Rock Description: Slightly weathered, blackish grey, fine grains are moderately compacted, **Shale.**
Rock Properties: Moderately hard and moderately strong rock.
(25.00 – 30.00)m:

Rock Description: Slightly weathered, brownish grey, medium to coarse grained loosely compacted, **Sandstone.**
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m). Dominantly horizontal with 3set fracture. Open fracture surfaces are planar, slightly rough to smooth and slightly altered.
Description of Core: Recovered core occurs as discontinuous. Cores are mostly in lengths of 30-100mm and rarely 100-200mm pieces at places.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is slightly weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 25

(00.00 – 02.30)m: Overburden.

(02.30 – 04.50)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge.

(04.50 – 25.00)m: **(04.50 – 15.00)m:**
Rock Description: Highly weathered, yellowish grey, fine grained, loosely compacted, **Sandstone.**
Rock Properties: Moderately soft and moderately weak rock.
(15.00 – 18.75)m:
Highly weathered, blackish grey, very fine grained **Shale.**
(18.75 – 25.00)m:
Highly weathered, black colour, very fine grained moderately compacted **Carbonaceous Shale** with **Coal**.
Rock Properties: Moderately soft and moderately weak rock.

Completely weathered, decomposed and disintegrated rock particles collected as sludge (at 06.75 – 08.25m, 09.75 – 10.50m, 12.75 – 14.25m, 16.75 – 18.75m, 19.50 – 20.25m.
Structural Condition: Very closely spaced (>15 nos./m). Dominantly horizontal with 3set fracture and locally vertical fracture (8.25-9.00m and 14.25-15.00m). Open fracture surfaces are planar, smooth and altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm and <30mm pieces at place.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 26

(00.00 – 02.00)m: Overburden.

(02.00 – 25.00)m: **(02.00 – 11.00)m:**
Rock Description: Highly weathered, yellowish grey, very fine grains are moderately compact, **Shale.**
Rock Properties: Moderately hard and medium weak to moderately strong rock.
(11.00 – 25.00)m:
Rock Description: Highly weathered, yellowish grey, medium to fine grains are loose to moderately compact, **Sandstone.**
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Closely spaced (15-8 nos/m) fracture. Dominantly horizontal fracture. Open fracture surfaces are planar, slightly rough to smooth and slightly altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm and locally 100-200mm.
Rock Mass Structure: The rock mass is very poor too poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 27

(00.00 – 03.00)m: Overburden.

(03.00 – 25.00)m: **Rock Description**: Highly weathered, brownish grey (up to 22.50m) then blackish grey, fine to very fine grained loose to moderately compacted, **Sandstone** interbedded with **Shale**.
Rock Properties: Soft and weak (up to 22.50m) followed by moderately hard and moderately strong rock.

Structural Condition: Closely spaced (15-8 nos./m). Dominantly horizontal with vertical fracture (at 19.50-20.25m). Open fracture surfaces are planar, smooth and altered (up to 25.25m) then slightly altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm and 100-200mm pieces at place.
Rock Mass Structure: The rock mass is very poor to poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 28

(00.00 – 04.75)m: Overburden.

(04.75 – 07.00)m: Completely weathered, decomposed and disintegrated rock particles

collected as sludge.

(07.00 – 30.00)m: **Rock Description**: Highly weathered (up to 21.25m) to slightly
(18.25 – 19.75)m: weathered, light grey to blackish grey, fine to very fine grains are loose to moderately compact, **Sandstone** interlayered with Shale and with pockets of highly weathered, decomposed **Shale** at 16.00-18.25m and coal streak also found at 29.50-30.00m depth**.**
Rock Properties: Medium soft and medium weak (up to 21.50m) followed by moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m). Dominantly horizontal with pockets of vertical fracture at 23.50-24.25m. Open fracture surfaces are planar, smooth and altered.
Description of Core: Recovered core occurs as discontinuous (up to 13.75m) followed by continuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly to slightly weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 29

(00.00 – 03.30)m: Overburden.
(03.30 – 25.00)m: **Rock Description**: Highly weathered, brownish grey to yellowish grey, fine to very fine grains are loose to moderately compact, **Interbedded sequence of Sandstone** and **Shale.**
Rock Properties: Medium soft and medium weak to moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m). Dominantly horizontal fracture. Open fracture surfaces are planar, smooth and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly to slightly weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 30

(00.00 – 03.25)m: Overburden.
(03.25 – 25.00)m: **(03.25 – 19.75)m:**
Rock Description: Moderately weathered, brownish grey to greyish white, coarse grains are loosely compact, **Sandstone.**
Rock Properties: Moderately hard and moderately strong rock.

(19.75 – 25.00)m:
Rock Description: Highly weathered, yellowish brown, fine grains are moderately compact, **Shale.**
Rock Properties: Moderately hard and medium weak to moderately strong rock.

Structural Condition: Closely spaced (up to 19.75m, 15-8 nos/m) followed by very closely spaced (>15 nos./m). Dominantly horizontal fracture. Open fracture surfaces are planar, slightly rough to smooth and slightly altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm and 100-200mm.
Rock Mass Structure: The rock mass is very poor too poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly to moderately weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 31
(00.00 – 02.75)m: Overburden.
(02.75 – 30.00)m: **(02.75 – 17.00)m:**
Rock Description: Highly weathered, yellowish grey to blackish grey, very fine grains are moderately compact, **Shale.**
Rock Properties: Soft and medium weak rock.
(17.00 – 30.00)m:
Rock Description: Highly weathered, yellowish grey (up to 26.75m) followed by moderately weathered, light grey, fine grains are loosely compact, **Sandstone.**
Rock Properties: Medium soft and medium weak.

Structural Condition: Very closely spaced (>15 nos/m). Dominantly horizontal fracture. Open fracture surfaces are planar, smooth and altered (up to 26.75m) to slightly altered.
Description of Core: Recovered core occurs as discontinuous (up to 26.00m) followed by continuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly to moderately weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 32

(00.00 – 03.50)m: Overburden.

(03.50 – 25.00)m: **(03.50 – 14.25)m:**
Rock Description: Highly weathered, yellowish brown, fine grains are loose to moderately compact, **Hornblende Schist.**
Rock Properties: Moderately hard and moderately strong rock.
(14.25 – 25.00)m:
Rock Description: Moderately weathered, brownish white, medium to fine grains are moderately compact, **Granite.**
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m). Dominantly horizontal with 3set fracture. Open fracture surfaces are planar, smooth and altered (up to 14.25m) then non-planar, rough and slightly altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly to moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 33

(00.00 – 02.80)m: Overburden.

(02.80 – 05.00)m: Moderately weathered, brownish white, quartzite.

(05.00 – 30.00)m: **Rock Description**: Highly weathered, brownish grey (up to 20.75m) to light greenish grey, fine grains are loose to moderately compact, **Hornblende Schist.**
Rock Properties: Medium soft and medium weak (up to 14.00m) followed by moderately hard and moderately strong rock.
Completely weathered, decomposed and disintegrated rock particles collected as sludge at 15.50-17.00m.
Structural Condition: Very closely spaced (up to 11.75m, >15 nos./m) then closely spaced (15-8 nos/m). Dominantly horizontal with inclined fracture (45^0 dip at 13.25-14.00m, 52^0 dip at 14.00-14.75m, 55^0 dip at 17.75-18.50m,). Open fracture surfaces are planar, slightly rough to smooth and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm and 100-200mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 34

(00.00 – 02.00)m: Overburden.

(02.00 – 07.25)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge.

(07.25 – 30.00)m: **(07.25 – 26.00)m:**
Rock Description: Highly weathered, yellowish brown, fine grains are loose to moderately compact, **Sandstone.**
Rock Properties: Moderately hard and moderately strong rock.
(26.00 – 30.00)m:
Rock Description: Slightly weathered, brownish grey, medium to fine grains are moderately compact, **Granite.**
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m). Dominantly horizontal fracture. Open fracture surfaces are planar, smooth and altered (up to 26.00m) then non-planar, rough and slightly altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm and 100-200mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly to slightly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 35

(00.00 – 02.00)m: Overburden.

(02.00 – 30.00)m: **(02.00 – 10.25)m:**
Rock Description: Highly weathered, yellowish grey, very fine grains are loosely compact, **Shale.**
Rock Properties: Soft and weak rock.
(10.25 – 17.50)m:
Rock Description: Highly weathered, yellowish grey, fine grains are loosely compact, **Sandstone.**
Rock Properties: Moderately soft and moderately weak rock.
(17.50 – 27.50)m:
Rock Description: Highly weathered, light greenish grey, medium grains are moderately compact, **Hornblende Schist**.
Rock Properties: Moderately hard and moderately strong rock.
(27.50 – 30.00)m:
Rock Description: Slightly weathered to almost fresh, greyish white with spotted black, medium grains are densely compact, **Granite gneiss**.
Rock Properties: Hard and strong rock.

Structural Condition: Very closely spaced (>15 nos./m). Dominantly horizontal with 3set fractures with pockets of inclined fracture (60^0 at 11.75-12.25m) and vertical fracture at 9.50-10.25m. Open fracture surfaces are planar, smooth to slightly rough and altered (up to 27.50m) then non-planar, rough and slightly altered.

Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm and 100-200mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly to slightly weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 36

(00.00 – 02.50)m: Overburden.

(02.50 – 04.75)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge.

(04.75 – 25.00)m: Highly weathered, yellowish grey, fine grains are loose to moderately compact, **Sandstone.**
Rock Properties: Moderately soft and moderately weak rock.
Completely weathered, decomposed and disintegrated rock particles collected as sludge at 16.00-16.75m, 17.50-18.25m, 19.00-19.75m, 22.75-23.50m.
Structural Condition: Very closely spaced (>15 nos./m). Dominantly horizontal with 3set fracture. Open fracture surfaces are apparently planar, slightly rough and altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm and <30mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 37

(00.00 – 03.30)m: Overburden.

(03.30 – 07.00)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge.

(07.00 – 30.00)m: **Rock Description**: Moderately weathered, brownish grey, medium grains are moderately compact, **Granite.**
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m). Dominantly horizontal fracture. Open fracture surfaces are non-planar, rough and altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm and rarely 100-200mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.

The formation rock is moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 38

(00.00 – 03.00)m: Overburden.

(03.00 – 08.25)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge with remnants of highly weathered, core pieces of sandstone at 5.25-6.00m depth.

(08.25 – 25.00)m: **(08.25 – 13.50)m:**
Rock Description: Highly weathered, light brownish grey, coarse grains are loose to moderately compact, **Sandstone.**
Rock Properties: Moderately hard and moderately strong rock.
(13.50 – 25.00)m:
Rock Description: Moderately weathered, brownish white, medium to fine grains are tightly compact, **Granite.**
Rock Properties: Hard and strong rock.

Structural Condition: Very closely spaced (>15 nos./m). Dominantly horizontal with vertical fracture at 16.00-17.50m. Open fracture surfaces are planar, smooth to rough and slightly altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm and 100-200mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly to high to moderately weathered and huge
amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 39

(00.00 – 02.00)m: Overburden.

(02.00 – 03.50)m: Completely weathered, decomposed and disintegrated rock particles

(04.25 – 05.00)m: collected as sludge.

(03.50 – 30.00)m: **Rock Description**: Highly weathered, light grey (up to 8.80m) then yellowish grey, medium to coarse grained, loose to moderately compacted, **Sandstone.**
Rock Properties: Moderately soft to moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m) with pockets of closely spaced (15-8 nos/m, 10.25-12.50m, 23.75-26.00m) fracture. Dominantly horizontal with vertical fracture (7.25-8.75m) and inclined fracture (45^0 - 60^0 at 6.50-7.25m, 17.75-18.50m, 21.50-23.75m). Open fracture surfaces are planar, rough and altered.
Description of Core: Recovered core occurs as discontinuous (up to 5.75m) followed by continuous framework. Cores are mostly in lengths of 30-100mm and 100-200mm and locally 100-300mm pieces at

place.
Rock Mass Structure: The rock mass is very poor with locally poor quality.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 40

(00.00 – 03.00)m: Overburden.

(03.00 – 25.00)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge with pockets of highly weathered, yellowish grey to greyish white, fine grained, moderately hard and moderately strong Sandstone at 3.75-6.00m, 6.75-7.50m, 11.25-12.00m and 15.00-18.75m depth.

BH : 41

(00.00 – 01.50)m: Overburden.

(01.50 – 05.25)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge with highly weathered, sandstone pieces at 3.00.-4.50m

(05.25 – 30.00)m: **Rock Description**: Highly weathered, yellowish brown, fine (upto 19.50m) to coarse grains are loose to moderately compacted, **Sandstone.**
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fracture. Dominantly horizontal fracture. Open fracture surfaces are apparently planar, slightly rough and altered.
Description of Core: Recovered core occurs as discontinuous (up to 19.50m) followed by continuous framework. Cores are mostly in lengths of 30-100mm and locally 100-200mm pieces at place.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 42

(00.00 – 01.50)m: Overburden.

(01.50 – 25.00)m: **Rock Description**: Highly weathered, brownish grey to light grey, fine to very fine grained, loosely compacted, interbedded sequence of **Sandstone and shale.**
Rock Properties: Soft to medium soft and medium weak rock.
Completely weathered, decomposed and disintegrated rock particles collected as sludge at 2.25-3.00m.
Structural Condition: Very closely spaced (>15 nos./m). Dominantly horizontal with 3set fracture. Open fracture surfaces are planar,

slightly rough to smooth and altered.
Description of Core: Recovered core occurs as discontinuous (up to 9.75m) followed by continuous framework. Cores are mostly in lengths of 30-100mm and few 100-200mm pieces at place.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly to slightly weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 43

(00.00 – 04.80)m: Overburden.
(04.80 – 06.50)m: Completely weathered, decomposed and disintegrated rock particles
(18.50 – 19.25)m: collected as sludge.
(23.75 – 25.25)m:
(06.50 – 30.00)m: **(06.50 – 27.50)m:**
Rock Description: Highly weathered, yellowish grey to light grey, medium to coarse grained, loosely compacted, **Sandstone.**
Rock Properties: Moderately soft to moderately hard and moderately strong rock.
(27.50 – 30.00)m:
Highly weathered, black colour, very fine grained, moderately compact, **Carbonaceous shale with Coal**.
Rock Properties: Moderately soft to moderately hard and moderately strong rock

Structural Condition: Very closely spaced (>15 nos./m). Dominantly horizontal with 3set fracture. Open fracture surfaces are planar, slightly rough and altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm and <30mm pieces at place.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 44

(00.00 – 03.00)m: Overburden.
(03.00 – 05.25)m: Completely weathered, decomposed and disintegrated rock particles
(12.75 – 13.50)m: collected as sludge.
(05.25 – 25.00)m: **(05.25 – 18.75)m:**
Rock Description: Complete to highly weathered, brownish grey, very fine grained, loosely compacted, **Shale.**
Rock Properties: Soft and weak rock.
(18.75 – 25.00)m:

Highly weathered, blackish grey, very fine grained, loosely compacted, **Carbonaceous shale with Coal**.
Rock Properties: Soft and weak rock.

Structural Condition: Very closely spaced (>15 nos./m) with pockets of closely spaced (15-8 nos/m) fractures. Dominantly horizontal with 3set fracture. Open fracture surfaces are planar, smooth and altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm and 100-200mm pieces at place.
Rock Mass Structure: The rock mass is very poor to poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is complete to highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 45

(00.00 – 01.60)m: Overburden.

(01.60 – 03.50)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge.

(03.50 – 30.00)m: **Rock Description**: Highly weathered, yellowish grey to light grey, medium to very fine grained, loose to moderately compacted, **Interbedded sequence of Sandstone and Shale.**
Rock Properties: Moderately soft and moderately weak to moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m) with pockets of closely spaced (15-8 nos/m at 11.75-13.25m, 22.25-28.25m). Dominantly horizontal with inclined fracture (46^0 dip at 17.75-18.50m, 57^0 dip at 18.50-19.25m). Open fracture surfaces are planar, slightly rough to smooth and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm and 100-200mm with locally 100-300mm pieces at 11.75-12.50m.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 46

(00.00 – 02.70)m: Overburden.

(02.70 – 10.75)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge.

(10.75 – 25.00)m: **(10.75 – 22.00)m:**
Rock Description: Highly weathered, yellowish grey (up to 19.75m) to brownish grey, medium grained, loosely compacted, **Sandstone.**
Rock Properties: Medium soft and medium weak rock.

(22.00 – 25.00)m:
Rock Description: Complete to highly weathered, blackish grey, very fine grained, moderately compacted, **Shale.**
Rock Properties: Soft and weak rock.
.
Structural Condition: Very closely spaced (>15 nos./m). Dominantly horizontal with vertical fracture (at 15.25-16.00m) and inclined fracture (62^0 dip at 19.00-19.75m, 47^0 dip at 19.75-20.50m, 55^0 dip at 20.50-21.25m). Open fracture surfaces are planar, slightly rough to smooth and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm and few 100-200mm pieces at place.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 47
(00.00 – 03.50)m: Overburden.
(03.50 – 25.00)m: **(03.50-9.50)m:**
Rock Description: Highly weathered, yellowish grey, bedded, very fine grains are loose to moderately compact, **Shale**.
Rock Properties: Soft and weak rock.
(9.50-25.00)m:
Rock Description: Highly to moderately weathered, yellowish grey to brownish grey, laminated, medium to coarse grains are loose to moderately compact, **Sandstone** with decomposed **Shale** (at 20.00-21.50m).
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m) with pockets of closely spaced (15-8 nos/m, at 14.10-18.50m) fractures. Dominantly horizontal with 3set fractures. Open fracture surfaces are planar, slightly rough to smooth and altered.
Description of Core: Recovered core occurs as discontinuous (up to 7.25m) to continuous framework. Cores are mostly in lengths of 30-100mm and 100-200mm with locally 100-300mm pieces at place.
Rock Mass Structure: The rock mass is very poor with pockets of poor (at 14.10-17.00m).

Partial (up to 14.00m) then high drill water loss has been noticed for the entire depth.
The formation rock is highly to moderately weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 48

(00.00 – 03.50)m: Overburden.

(03.50 – 25.00)m: **(03.50-17.00)m:**

Rock Description: Highly weathered, yellowish grey to light grey, bedded, medium to fine grains are loose to moderately compact, **Sandstone** with locally interlayered with shale.

Rock Properties: Medium soft to moderately hard and moderately strong rock.

(17.00-25.00)m:

Rock Description: Highly weathered, blackish grey, laminated, very fine grains are moderately compact, **Carbonaceous Shale**, with coal streaks.

Rock Properties: Medium soft and weak rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal with 3set fractures. Open fracture surfaces are planar, slightly rough to smooth and altered.

Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm, with rare 100-200mm pieces at place.

Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.

The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 49

(00.00 – 02.50)m: Overburden.

(02.50 – 30.00)m: **(02.50-19.50)m:**

Rock Description: Highly weathered, brownish grey to dark grey, bedded, fine to very fine grains are loose to moderately compact, **Shale** interbedded with sandstone.

Rock Properties: Soft to medium soft and medium weak rock.

(19.50-30.00)m:

Rock Description: Slightly weathered, brownish grey to light grey, bedded, very fine grains are moderately compact, **Sandstone** interlayered with Shale.

Rock Properties: Medium soft to moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal with 3set fractures. Open fracture surfaces are planar, slightly rough to smooth and altered.

Description of Core: Recovered core occurs as discontinuous (up to 12.25m) followed by continuous framework. Cores are mostly in lengths of 30-100mm, with rare 100-200mm pieces at place.

Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.

The formation rock is highly weathered and huge amount of the rock

mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 50

(00.00 – 03.20)m: Overburden.

(03.20 – 07.00)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge.

(07.00 – 30.00)m: **(07.00-26.50)m:**

Rock Description: Highly to moderately weathered, brownish grey, bedded, medium to coarse grains are moderately compact, **Sandstone** with pockets of greyish black, very fine grained Carbonaceous **Shale and coal**.

Rock Properties: Moderately hard and moderately strong.

(26.50-30.00)m:

Rock Description: Slightly weathered, light grey, bedded, fine grains are moderately compact, **Sandstone interlayered with Shale.**

Rock Properties: Moderately hard and moderately strong.

Structural Condition: Closely spaced (15-8 nos./m) with pockets of very closely spaced fractures (>15 nos/m at 10.75-13.00m, 16.75-19.00m). Dominantly horizontal with pockets of vertical fracture at 10.75-11.00m and 25.75-26.50m and inclined fracture (65^0 dip at 10.00-10.75m, 52^0 dip at 15.25-16.00m) Open fracture surfaces are planar, slightly rough to smooth and slightly altered.

Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm and 100-200mm pieces with rarely 100-300mm at place.

Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.

The formation rock is highly to moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 51

(00.00 – 06.00)m: Overburden.

(06.00 – 30.00)m: **(06.00-14.25)m:**

Rock Description: Slightly weathered, greyish white, bedded, coarse grains are loosely compact, **Sandstone**.

Rock Properties: Moderately hard and moderately strong.

Completely weathered, decomposed and disintegrated rock particles collected as sludge at 10.50-13.50m depth.

(14.25-30.00)m:

Rock Description: Moderate to slightly weathered, blackish grey, bedded, medium to fine grains are loose to moderately compact, **Sandstone interbedded with Shale.**

Rock Properties: Moderately hard and moderately strong.

Structural Condition: Very close (>15 nos/m, up to 21.75m) followed

by closely spaced (15-8 nos./m). Dominantly horizontal. Open fracture surfaces are planar, slightly rough to smooth and slightly altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm and 100-200mm pieces at places.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderate to slightly weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 52

(00.00 – 06.50)m: Overburden.

(06.50 – 25.00)m: **(06.50-17.00)m:**
Rock Description: Highly weathered, yellowish grey to light grey (up to 16.50m) followed by blackish grey, bedded, medium to coarse grains are loose to moderately compact, **Sandstone**.
Rock Properties: Moderately hard and moderately strong rock.
(17.00-25.00)m:
Rock Description: Highly weathered, blackish grey, laminated, very fine grains are moderately compact, **Shale**, with coal streaks.
Rock Properties: Soft and weak rock.

Structural Condition: Very closely spaced (>15 nos./m), with locally closely spaced (15-8 nos/m, at 9.50-11.00m, 11.75-13.50m) fractures. Dominantly horizontal with locally inclined fractures (55^0-60^0 dip at 8.75-10.25m) are also observed. Open fracture surfaces are planar, slightly rough to smooth and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm, with rare 100-200mm pieces at place.
Rock Mass Structure: The rock mass is very poor with locally poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 53

(00.00 – 06.00)m: Overburden.

(06.00 – 30.00)m: **(06.00-11.25)m:**
Rock Description: Highly weathered, yellowish grey, laminated, very fine grains are loosely compact, **Shale**.
Rock Properties: Soft and weak rock.
(11.25-15.75)m:
Rock Description: Moderately weathered, yellowish grey, bedded, medium to coarse grains are loose to moderately compact,

Sandstone.
Rock Properties: Moderately hard and moderately strong rock.
(15.75-25.40)m:
Rock Description: Moderately weathered, yellowish grey, bedded, coarse grains are loose to moderately compact, **Gritty Sandstone.**
Rock Properties: Moderately hard and moderately strong rock
(24.25-30.00)m:
Rock Description: Moderate to slightly weathered, light grey to blackish grey, bedded, fine to medium grains are moderately compact, **Sandstone interlayered with Shale and coal streaks at 26.50-27.00m depth**

Structural Condition: Very closely spaced (up to 19.50m, >15 nos./m, followed by closely spaced (15-8 nos/m) fractures. Dominantly horizontal with locally inclined fracture (73^0 dip at 24.25-15.00m, 75^0 dip at 27.00-27.75m) and vertical fractures (at 14.25-15.75m depth) are also observed. Open fracture surfaces are planar, slightly rough to smooth and altered.
Description of Core: Recovered core occurs as discontinuous (up to 15.75m) followed by continuous framework. Cores are mostly in lengths of 30-100mm, with rare 100-200mm pieces.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 54
(00.00 – 06.00)m: Overburden.
(06.00 – 25.00)m: **(06.00-11.50)m:**
Rock Description: Highly weathered, yellowish grey to brownish grey, laminated, very fine grains are loosely compact, **Shale**.
Rock Properties: Soft and weak rock.
(11.50-25.00)m:
Rock Description: Moderately weathered, light grey to brownish grey, bedded, medium to coarse grains are loose to moderately compact, **Sandstone.**
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (up to 22.50m, >15 nos./m, followed by closely spaced (15-8 nos/m) fractures. Dominantly horizontal with locally inclined fracture (47^0 dip at 12.75-13.50m) and vertical fractures (at 11.25-12.00m, 12.00-12.75m, 20.25-21.00m depth) are also observed. Open fracture surfaces are planar, slightly rough to smooth and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm, with rare 100-200mm pieces and rarely 100-300mm pieces at place.
Rock Mass Structure: The rock mass is very poor with locally poor quality.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge (up to 20.25m) then modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 55

(00.00 – 05.80)m: Overburden.

(05.80 – 30.00)m: **(05.80-18.50)m:**

Rock Description: Highly weathered, yellowish grey, bedded, medium to coarse grains are moderately compact, gritty **Sandstone**.
Rock Properties: Moderately hard and moderately strong rock.

(18.50-20.00)m:

Rock Description: Moderately weathered, blackish grey, laminated, very fine grains are moderately compact, carbonaceous **Shale**, with coal streaks.
Rock Properties: Soft and weak rock.

Structural Condition: Very closely spaced (>15 nos./m), with locally closely spaced (15-8 nos/m at 11.75-17.75m) fractures. Dominantly 3-sets and horizontal fractures. Few vertical fractures (09.50, 19.25, 24.25 m depths) are also observed Open fracture surfaces are non-planar, rough and altered.
Description of Core: Recovered core occurs as discontinuous (up to 11.75m) to continuous framework. Cores are mostly in lengths of 30-100mm, with rare 100-200mm pieces at place.
Rock Mass Structure: The rock mass is very poor with locally poor quality.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly to moderately weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 56

(00.00 – 04.50)m: Overburden.

(04.50 – 13.50)m:

(04.50 – 30.00)m: **Rock Description**: Highly weathered, brownish grey (up to 17.25m) then yellowish grey, medium to coarse grains are loosely compact **Gritty Sandstone**.
Rock Properties: Moderately soft to moderately hard and moderately strong rock.
Completely weathered, decomposed and disintegrated rock particles collected as sludge at 6.00-12.75m, 13.50-15.00m, 18.75-20.25m, 21.75-23.25m and 24.75-27.75m depth.
Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fractures. Open fracture surfaces are planar, slightly rough and altered.

Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm and <30mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 57

(00.00 – 06.00)m: Overburden.

(06.00 – 13.50)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge.

(13.50 – 25.00)m: **Rock Description**: Slightly weathered, brownish grey (up to 20.25m) then greyish white to light grey, medium to coarse grains are moderately compact **Sandstone**.
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m up to 15.00m) to closely spaced (15-8 nos/m) fractures. Dominantly horizontal fractures. Open fracture surfaces are planar, slightly rough and altered.
Description of Core: Recovered core occurs as discontinuous (up to 14.25m) followed by continuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderate to slightly weathered and huge (up to 24.00m) to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 58

(00.00 – 04.50)m: Overburden.

(04.50 – 30.00)m: **Rock Description**: Highly weathered, yellowish grey to light grey, medium grains are loosely compact **Sandstone** with pockets of completely weathered, yellowish grey to blackish grey, very fine grained, decomposed **Shale** at 24.00-26.50m and 27.00-28.50m depth.
Rock Properties: Soft and weak to medium soft and medium weak rock.
Completely weathered, decomposed and disintegrated rock particles collected as sludge at 6.00-10.50m.
Structural Condition: Very closely spaced (>15 nos./m) with pockets of closely spaced (15-8 nos/m 16.50-19.50m then 8.5 nos/m up to 24.00m) fractures. Dominantly horizontal with pockets of vertical fracture at 12.75-13.50m and few inclined fractures (50^0 dip at 13.50-14.25m, 60^0 dip at 17.25-18.00m, 46^0 dip at 18.75-20.25m) are observed. Open fracture surfaces are planar, slightly rough and

altered.
Description of Core: Recovered core occurs as discontinuous (up to 13.50m) followed by continuous framework. Cores are mostly in lengths of 30-100mm with 100-200mm and 100-300mm.
Rock Mass Structure: The rock mass is very poor (up to 16.50m) followed by very poor to poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 59

(00.00 – 03.50)m: Overburden.

(03.50 – 05.00)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge.

(05.00 – 25.00)m: **(05.00-14.75)m:**
Rock Description: Highly weathered, yellowish grey, bedded, coarse grains are loosely compact, medium soft to moderately hard and moderately strong **Sandstone**.
Rock Properties: Medium soft to moderately hard and moderately strong rock.
(14.75-25.00)m:
Rock Description: Moderately to slightly weathered, light grey (up to 17.20m) then brownish grey, bedded, fine grains are moderately compact, **Sandstone** interlayered with **Shale**.
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Closely spaced (8-5 nos/m up to 14.75m then 15-8 nos/m)up to 19.25m depth followed by very closely spaced (>15 nos/m) fractures. Dominantly horizontal with pockets of vertical fracture (at 14.75-15.50m) and inclined fractures (50^0 dip at 17.00-17.75m, 52^0 dip at 17.75-18.50m, 48^0 dip at 18.50-20.00m) are also observed. Open fracture surfaces are planar, slightly rough to smooth and altered (up to 14.75m) to slightly altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm, with rare 100-200mm pieces at place.
Rock Mass Structure: The rock mass is very poor with locally poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly to slightly weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 60

(00.00 – 03.50)m: Overburden.

(03.50 – 25.00)m: **Rock Description**: Highly weathered, yellowish grey, coarse grains are loosely compact **Gritty Sandstone.**

Rock Properties: Medium soft and medium weak rock.
Completely weathered, decomposed and disintegrated rock particles collected as sludge at 4.50-6.25m, 10.75-12.25m, 16.00-16.75m, 18.25-19.00m, 19.75-20.50m, 21.25-22.75m, 24.25-25.00m.

Structural Condition: Very closely spaced (>15 nos./m) with pockets of closely spaced (15-8 nos/m 7.00-16.00m) fractures. Dominantly horizontal with few inclined fractures (50^0 - 60^0 dip at 07.75-9.25m, 15.25-16.00m) are observed. Open fracture surfaces are planar, slightly rough and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm with 100-200mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge with locally modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge with locally modest amount of core loss occurred.

BH : 61

(00.00 – 07.00)m: Overburden.

(07.00 – 30.00)m: **07.00-21.25m:**
Rock Description: Highly weathered, yellowish grey, fine grains are loosely compact **Sandstone.**
Rock Properties: Medium soft and medium weak rock.

Structural Condition: Very closely spaced (>15 nos./m) with pockets of closely spaced (15-8 nos/m 7.00-16.00m) fractures. Dominantly horizontal with few inclined fractures (50^0 - 60^0 dip at 07.75-9.25m, 15.25-16.00m) are observed. Open fracture surfaces are planar, slightly rough and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm with 100-200mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 62

(00.00 – 03.60)m: Overburden.

(03.60 – 06.25)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge.

(06.25 – 25.00)m: **Rock Description**: High (up to 7.75m) to moderately weathered, yellowish grey, medium grains are loosely compact **Sandstone.**
Rock Properties: Medium soft to moderately hard and moderately

strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fractures. Open fracture surfaces are planar, slightly rough to smooth and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm with 100-200mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly to moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 63

(00.00 – 02.50)m: Overburden.

(02.50 – 25.00)m: **02.50-19.00m:**
Rock Description: Highly weathered, yellowish grey to brownish grey, medium to fine grains are loose to moderately compact **Sandstone**.
Rock Properties: Medium soft to moderately hard and moderately strong rock.
Completely weathered, decomposed and disintegrated rock particles collected as sludge at 3.25-4.00m.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal with few inclined fractures (60^0 dip at 6.25-7.00m, 79^0 dip at 23.50-24.25m) and vertical fractures (at 11.50-12.25m and 14.25-15.25m) are observed. Open fracture surfaces are planar, smooth and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm with 100-200mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 64

(00.00 – 03.50)m: Overburden.

(03.50 –06.50)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge.

(06.50 – 25.00)m: **Rock Description**: Moderately weathered, brownish grey to light whitish grey, coarse grains are loose to moderately compact **Sandstone.**
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (up to 11.75m, >15

nos./m) followed by closely spaced (15-8 nos/m) fractures. Dominantly horizontal with few inclined fractures (45^0 dip at 13.25-14.00m, 52^0 dip at 14.00-14.75m, 55^0 dip at 17.75-18.50m) are observed. Open fracture surfaces are planar, slightly rough to smooth and altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm with 100-200mm.
Rock Mass Structure: The rock mass is very poor with locally poor quality.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderately weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 65

(00.00 – 04.30)m: Overburden.
(04.30 – 11.00)m: Completely weathered, decomposed and disintegrated rock particles
(23.00 – 26.00)m: collected as sludge.
(11.00 – 30.00)m: **(11.00-15.50)m:**
Rock Description: Highly weathered, brownish grey, massive, medium grains are tightly compact **Granite**.
Rock Properties: Hard and moderately strong rock.
(15.50-30.00)m:
Rock Description: Moderately weathered, yellowish grey, indistinctly foliated, fine to medium grains are moderately compact **Hornblende schist**.
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m up to 17.25m) to closely spaced (15-8 nos/m) fractures. Dominantly horizontal fractures. Open fracture surfaces are non-planar, rough and altered.
Description of Core: Recovered core occurs as discontinuous (up to 16.50m) to continuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

High (up to 5.75m) then partial drill water loss has been noticed for the entire depth.
The formation rock is highly to moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 66

(00.00 – 02.30)m: Overburden.
(02.30 – 06.00)m: Completely weathered, decomposed and disintegrated rock particles
(18.75 – 22.50)m: collected as sludge.
(06.00 – 30.00)m: **Rock Description**: Moderately weathered, light yellowish grey,

medium to fine grains are moderate to tightly compact **Granite Schist.**
Rock Properties: Moderately hard and moderately strong to strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal with pockets of vertical fracture at 22.50-23.25m, 24.00-24.75m depth. Open fracture surfaces are non-planar, rough and slightly altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm and rarely 100-200mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 67

(00.00 – 03.00)m: Overburden.

(03.00 – 30.00)m: **Rock Description**: Highly weathered, brownish grey (up to 14.25m) followed by moderately weathered, pinkish grey, medium grains are moderately compact **Granite**.
Rock Properties: Moderately hard and moderately strong rock.
Completely weathered, decomposed and disintegrated rock particles collected as sludge at 4.50-6.00m
Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal with 3set fractures and locally vertical fractures at 18.00-18.75m, 21.00-22.50m, 27.00-27.75m depth. Open fracture surfaces are non-planar, rough and altered (up to 14.25m) to slightly altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly to moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 68

(00.00 – 04.00)m: Overburden.

(04.00 – 06.25)m: Completely weathered, decomposed and disintegrated rock particles

(07.75 – 10.75)m: collected as sludge.

(06.25 – 25.00)m: **06.25 – 16.00)m:**
Rock Description: Highly weathered, yellowish grey, medium grains are loosely compact **Sandstone**.
Rock Properties: Medium soft and medium weak rock.
16.00 – 25.00)m:

Rock Description: Moderately weathered, whitish brown, medium grains are moderately compact **Granite**.
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fractures. Open fracture surfaces are planar, smooth and altered (up to 16.00m) followed by non-planar, rough and slightly altered.
Description of Core: Recovered core occurs as discontinuous (up to 13.75m) followed by continuous framework. Cores are mostly in lengths of 30-100mm with pockets of 100-200mm lengths at 22.75-23.50m depth.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly to moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 69

(00.00 – 03.00)m: Overburden.

(03.00 – 04.50)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge.

(04.50 – 25.00)m: **Rock Description**: Moderately weathered, pinkish white with spotted black, medium grains are tightly compact **Granite.**
Rock Properties: Hard and strong rock.

Structural Condition: Very close (up to 18.00m, >15 nos./m) followed by closely spaced fractures (15-8 nos/m). Dominantly horizontal with 3 set fracture (upto 18.00m) followed by horizontal with locally inclined fracture (72^0 dip at 18.00-18.75m, 53^0 dip at 20.25-21.00m, 57^0 dip at 23.25-24.00m), and vertical fracture at 7.50-8.25m, 12.75-13.50m,. 15.75-16.50m, 21.00-21.75m depth. Open fracture surfaces are non-planar, rough and slightly altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm and rarely 100-200mm.
Rock Mass Structure: The rock mass is very poor.

Partial with pockets of high drill water loss (12.75-16.50m) has been noticed for the entire depth.
The formation rock is moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 70

(00.00 – 03.00)m: Overburden.

(03.00 – 06.75)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge with remnants of core pieces at 5.25-6.00m.

(06.75 – 30.00)m: **Rock Description**: Highly weathered, brownish grey, indistinctly

foliated, medium grains are moderately compact **Granite Schist**.
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal with locally inclined fracture (66^0 dip at 7.50-8.25m). Open fracture surfaces are non-planar, rough and slightly altered.
Description of Core: Recovered core occurs as discontinuous (up to 14.25m) followed by continuous framework. Cores are mostly in lengths of 30-100mm and rarely 1000-200mm at 16.50-17.25m depth.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 71

(00.00 – 01.50)m: Overburden.

(01.50 – 09.00)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge.

(09.00 – 30.00)m: **Rock Description**: High (up to 15.00m) to moderately weathered, deep brown to light brownish grey, indistinctly foliated, medium to fine grains are moderately compact **Granite Schist**.
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal with locally inclined fracture (50^0 dip at 16.50-17.25m). Open fracture surfaces are non-planar, rough and slightly altered.
Description of Core: Recovered core occurs as discontinuous (up to 09.75m) followed by continuous framework. Cores are mostly in lengths of 30-100m.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly to moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 72

(00.00 – 02.60)m: Overburden.

(02.60 – 08.25)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge.

(08.25 – 30.00)m: **Rock Description**: Highly weathered, greyish brown (up to 12.75m) to moderately weathered, brownish grey, indistinctly foliated, medium grains are moderately compact **Granite Gneiss**.
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures.

Dominantly horizontal with 3set fractures and locally vertical fracture at 21.00-21.75m and inclined fracture (63^0 dip at 21.00-21.75m, 52^0 dip at 23.25-24.00m). Open fracture surfaces are non-planar, rough and altered (up to 12.75m then slightly altered.
Description of Core: Recovered core occurs as discontinuous (up to 21.00m) followed by continuous framework. Cores are mostly in lengths of 30-100mm and rarely 1000-200mm at 29.25-30.00m depth.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 73

(00.00 – 01.20)m: Overburden.

(01.20 – 06.50)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge.

(06.50 – 25.00)m: **Rock Description**: Moderately weathered, brownish white, indistinctly foliated, medium grains are tightly compact **Granite schist**.
Rock Properties: Moderately hard to hard and strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fracture mixed with inclined fracture (48^0 dip at 15.50-16.25m, 50^0 dip at 16.25-17.00m, 55^0 dip at 24.50-25.00m). Open fracture surfaces are non-planar, rough and slightly altered.
Description of Core: Recovered core occurs as discontinuous (up to 11.75m) to continuous framework. Cores are mostly in lengths of 30-100mm (up to 22.25m) followed by 100-200mm pieces.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 74

(00.00 – 01.70)m: Overburden.

(01.70 – 07.75)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge with remnants of highly weathered Granite Schist at 4.75-5.50m, 6.25-7.00m depth.

(04.75 – 25.00)m: **Rock Description**: Moderately weathered, brownish grey (up to 10.00m) followed by slightly weathered, brownish white, medium grains are tightly compact **Granite schist**.
Rock Properties: Hard and strong rock.

Structural Condition: Very closely spaced (up to 19.00m, >15 nos./m) followed by closely spaced fractures (15-8 nos/m). Dominantly horizontal fracture mixed with vertical fracture at 13.75-15.25m and inclined fracture (79^0 dip at 09.25-10.00m, 77^0 dip at 10.00-10.75m

and 65^0 dip at 22.75-23.50m). Open fracture surfaces are non-planar, rough and slightly altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm and 100-200mm pieces.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 75

(00.00 – 03.50)m: Overburden.

(03.50 – 20.00)m: **Rock Description**: High (up to 18.00m) to moderately weathered, brownish grey, indistinctly foliated, fine grains are moderately compact **Hornblende-schist**.
Rock Properties: Moderately hard and moderately strong rock.
Completely weathered, decomposed and disintegrated rock fragments of Hornblende schist at 06.00-09.75m, 11.25-12.75m, 13.80-15.00m.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fractures. Open fracture surfaces are non-planar, rough and slightly altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly to moderately weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 76

(00.00 – 03.80)m: Overburden.

(03.80 – 08.25)m: Completely weathered, decomposed and disintegrated rock fragments of Hornblende schist.

(08.25 – 25.00)m: **Rock Description**: Moderately weathered, dark greenish grey, indistinctly foliated, fine to medium grains are moderately compact **Hornblende schist**.
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly 3-sets of fractures. Rare vertical fracture at 1500-15.75m, 17.25-18.00m depth. Open fracture surfaces are non-planar, rough and altered.
Description of Core: Recovered core occurs as discontinuous (up to 23.00m) to continuous framework. Cores are mostly in lengths of 30-100mm, with pockets of 100-200mm pieces at 14.25-15.00m.

Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 77

(00.00 – 01.50)m: Overburden.

(01.50 – 03.00)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge.

(03.00 – 25.00)m: **Rock Description**: Moderately weathered, dark greenish brown to dark greenish, indistinctly foliated, fine to medium grains are densely compact **Hornblende-schist**.
Rock Properties: Hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fractures. Open fracture surfaces are non-planar, rough and slightly altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 78

(00.00 – 03.25)m: Overburden.

(03.25 – 25.00)m: **Rock Description**: Highly weathered (up to 18.25m) then moderately weathered, dark greenish brown (up to 18.25m) followed by greenish grey, indistinctly foliated, fine grains are moderately compact **Hornblende-schist**.
Rock Properties: Moderately hard and moderately strong rock.
Completely weathered, decomposed and disintegrated rock fragments of Hornblende schist at 04.00-06.25m.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly 3-sets of fractures (up to 17.75m) followed by dominant horizontal with inclined fracture at (56^0 20.50-21.25m 58^0 21.25-22.00m). Open fracture surfaces are non-planar, rough and slightly altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm with pockets of 100-200mm at 23.50-24.25m.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly to moderately weathered and huge

amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 79

(00.00 – 05.50)m: Overburden.

(05.50 – 30.00)m:

(05.50-07.00)m:

Rock Description: Highly weathered, light grey, massive, coarse grains are tightly compact **Quartzite**.

Rock Properties: Hard and strong rock.

(07.00-30.00)m:

Rock Description: Moderately weathered, dark greenish grey, indistinctly foliated, fine to medium grains are densely compact **Hornblende schist**.

Rock Properties: Hard and strong rock.

Structural Condition: Very closely spaced (>15 nos./m up to 17.25m) to closely spaced (15-8 nos/m) fractures. Dominantly horizontal fractures. Open fracture surfaces are non-planar, rough and altered.

Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm.

Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.

The formation rock is highly to moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 80

(00.00 – 02.80)m: Overburden.

(02.80 – 11.75)m: Completely weathered, decomposed and disintegrated rock

(17.75 – 20.75)m: fragments, with highly weathered, brownish grey, medium grained Hornblende schist at 8.00-9.50m. .

(11.75 – 25.00)m: **Rock Description**: Highly weathered, dark greenish grey, indistinctly foliated, fine to medium grains are densely compact **Hornblende-schist**.

Rock Properties: Hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fractures. Open fracture surfaces are non-planar, rough and slightly altered.

Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm, with pockets of 100-200mm pieces at 23.75-24.50m depth.

Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.

The formation rock is Highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result

huge amount of core loss occurred.

BH : 81

(00.00 – 05.00)m: Overburden.

(05.00 – 30.00)m: **Rock Description**: Highly weathered, yellowish grey, indistinctly foliated, fine grains are moderately compact **Hornblende schist**.
Rock Properties: Moderately hard and moderately strong rock.
Completely weathered, decomposed and disintegrated rock particles collected as sludge at 12.50-19.25m depth.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fractures with 3set fracture. Open fracture surfaces are non-planar, rough and altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm with rarely 100-200mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 82

(00.00 – 02.70)m: Overburden.

(02.70 – 25.00)m: **Rock Description**: Highly weathered, yellowish brown, indistinctly foliated, medium grains are moderately compact **Granite schist**.
Rock Properties: Moderately hard and moderately strong rock.
Completely weathered, decomposed and disintegrated rock particles collected as sludge at 11.50-14.50m depth.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fractures with pockets of vertical fracture at 17.50-18.00m. Open fracture surfaces are non-planar, rough and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 83

(00.00 – 02.50)m: Overburden.

(02.50 – 25.00)m: **Rock Description**: Highly weathered, yellowish grey, indistinctly foliated, medium grains are moderately compact **Quartz biotite schist**.
Rock Properties: Moderately hard and moderately strong rock.
Completely weathered, decomposed and disintegrated rock particles

collected as sludge at 10.00-11.50m and 17.50-22.75m depth.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fractures with pockets of inclined fractures (43^0 dip at 2.50-3.25m, 45^0 dip at 4.25-5.50m). Open fracture surfaces are non-planar, rough and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm and locally 100-200mm pieces.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 84

(00.00 – 04.35)m: Overburden.

(04.35 – 30.00)m: **Rock Description**: High (up to 20.50m) to slightly weathered, greenish grey, indistinctly foliated, fine grains are tightly compact **Hornblende schist**.
Rock Properties: Hard and strong rock.
Completely weathered, decomposed and disintegrated rock particles collected as sludge at 06.50-08.00m, 09.50-12.50m depth.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal with locally vertical fracture at 18.50-19.25m and inclined fractures (60^0 dip at 15.50-16.25m, 53^0 dip at 19.25-20.00m). Open fracture surfaces are non-planar, rough and altered (up to 22.25m) slightly altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm with locally 100-200mm at 16.25-17.00m, 19.25-20.00m and 25.25-26.00m depth.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly to slightly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 85

(00.00 – 03.70)m: Overburden.

(03.70 – 25.00)m: **Rock Description**: High (up to 18.00m) to moderately weathered, brownish grey, indistinctly foliated, medium grains are moderately compact **Hornblende schist**.
Rock Properties: Moderately hard and moderately strong rock.
Completely weathered, decomposed and disintegrated rock particles collected as sludge at 06.00-09.75m, 11.25-12.75m, 13.50-15.00m depth.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal with 3set fractures. Open fracture surfaces are planar, rough and altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly to moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 86

(00.00 – 04.00)m: Overburden.
(04.00 – 04.75)m: Completely weathered, decomposed and disintegrated rock fragments
(07.75 – 08.50)m: collected as sludge.
(19.00 – 22.00)m:

(04.75 – 25.00)m: **Rock Description**: Highly weathered, brownish grey to greenish grey, medium grains are moderately compact **Hornblende Gneiss**.
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal with locally vertical fracture (at 16.00-17.50m depth). Open fracture surfaces are planar, slightly rough and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 87

(00.00 – 04.50)m: Overburden.
(04.50 – 25.00)m: **Rock Description**: Highly weathered, brownish grey to greenish grey, medium grains are moderately compact **Hornblende Gneiss**.
Rock Properties: Moderately hard and moderately strong rock.
Completely weathered, decomposed and disintegrated rock fragments collected as sludge 9.00-10.50m depth.
Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal with locally inclined fractures (60^0 dip at 19.50-20.25m, 43^0 dip at 21.75-22.50m, 54^0 dip at 22.50-23.25m) . Open fracture surfaces are planar, slightly rough and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm with locally 100-200mm pieces.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.

The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 88

(00.00 – 02.70)m: Overburden.

(02.70 – 10.25)m: Completely weathered, decomposed and disintegrated rock fragments collected as sludge.

(10.25 – 25.00)m: **Rock Description**: Highly (up to 14.00m) to moderately weathered, brownish grey, coarse grains are loose (up to 13.25m) to moderately compact **Granite**.
Rock Properties: Moderately hard and moderately strong rock.
Completely weathered, decomposed and disintegrated rock fragments collected as sludge at 19.25-20.00m, 20.75-21.50m, 23.00-23.75m.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fracture. Open fracture surfaces are non-planar, rough and altered (up to 15.50m) to slightly altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is Highly to moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 89

(00.00 – 03.00)m: Overburden.

(03.00 – 25.00)m: **Rock Description**: Moderately weathered, dark greenish, indistinctly foliated, fine to medium grains are densely compact **Hornblende schist**.
Rock Properties: Hard and strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fractures. Open fracture surfaces are non-planar, rough and highly altered.
Description of Core: Recovered core occurs as discontinuous (up to 19.50m) to continuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 90

(00.00 – 01.60)m: Overburden.

(01.60 – 14.25)m: Completely weathered, decomposed and disintegrated rock fragments collected as sludge.

(14.25 – 30.00)m: **(14.25 – 27.75)m:**

Rock Description: Highly weathered, brownish grey to blackish grey, indistinctly foliated, fine grains are loosely to moderately compact **Hornblende schist**.

Rock Properties: Moderately hard and moderately strong rock.

(27.75 – 30.000m):

Rock Description: Slightly weathered, pinkish grey, massive, coarse grains are tightly compact **Granite**.

Rock Properties: Hard and strong rock.

Structural Condition: Very closely to closely spaced (>15 to 15-8 nos./m) fractures. Dominantly 3-sets of fractures. Open fracture surfaces are non-planar, rough and altered (up to 27.75m) to slightly altered.

Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm.

Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.

The formation rock is highly to slightly weathered and huge of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 91

(00.00 – 03.60)m: Overburden.

(03.60 – 11.00)m: Completely weathered, decomposed and disintegrated rock fragments collected as sludge.

(11.00 – 30.00)m: **Rock Description**: Moderately (up to 29.00m) to slightly weathered, yellowish brown (up to 29.00m) to light grey, indistinctly foliated, medium to fine grains are tightly compact **Quartz-biotite schist**.

Rock Properties: Hard and strong rock.

Structural Condition: Very closely to closely spaced (>15 to 15-8 nos./m) fractures. Dominantly 3-sets of fractures with pockets of inclined (65° at 23.75-24.50m and 56° at 28.25-29.00) fracture. Open fracture surfaces are apparently planar, rough and altered (up to 29.00m) to slightly altered.

Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm with rare 100-200mm pieces at places.

Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.

The formation rock is moderately to slightly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 92

(00.00 – 02.90)m: Overburden.

(02.90 – 12.50)m: Completely weathered, decomposed and disintegrated rock fragments collected as sludge.

(12.50 – 30.00)m: **(12.25 – 28.00)m:**

Rock Description: Highly weathered, brownish grey, indistinctly foliated, fine grains are loosely to moderately compact **Hornblende schist**.

Rock Properties: Moderately hard and moderately strong rock.

(28.00 – 30.000m):

Rock Description: Slightly weathered, pinkish grey, massive, coarse grains are tightly compact **Granite**.

Rock Properties: Hard and strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly 3-sets of fractures. Open fracture surfaces are non-planar, rough and altered (up to 28.00m) to slightly altered.

Description of Core: Recovered core occurs as discontinuous (up to 28.00m) to continuous framework. Cores are mostly in lengths of 30-100mm.

Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.

The formation rock is highly to slightly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 93

(00.00 – 01.40)m: Overburden.

(01.40 – 09.50)m: Completely weathered, decomposed and disintegrated rock fragments collected as sludge.

(09.50 – 30.00)m: **Rock Description**: Highly (up to 17.75m) to moderately weathered, yellowish grey (up to 17.75m) to brownish grey, indistinctly foliated, medium to fine grains are moderately compact **Hornblende schist**.

Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly 3-set with horizontal fracture (up to 22.25m) followed by horizontal fracture. Open fracture surfaces are non-planar, rough and altered.

Description of Core: Recovered core occurs as discontinuous framework (up to 23.00m) followed by continuous core recovery. Cores are mostly in lengths of 30-100mm with few <30mm.

Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.

The formation rock is highly to moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 94

(00.00 – 02.60)m: Overburden.

(02.60 – 05.50)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge.

(05.50 – 25.00)m: **(05.50-06.25)m:**

Rock Description: Highly weathered, greenish brown, indistinctly foliated, fine to medium grains are moderately compact **Hornblende schist**.

Rock Properties: Moderately hard and weak rock.

(06.25-25.00)m:

Rock Description: Moderately weathered, pinkish grey, massive, fine to medium grains are densely compact **Granite**.

Rock Properties: Hard and strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly 3-sets of fractures. Open fracture surfaces are non-planar, rough and altered.

Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm, with rare 100-200mm pieces at place.

Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.

The formation rock is highly to moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 95

(00.00 – 02.70)m: Overburden.

(02.70 – 05.00)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge.

(05.00 – 25.00)m: **Rock Description**: Highly weathered, greenish grey (up to 13.25m) to brownish grey, foliated, fine grains are moderately compact **Hornblende schist**.

Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal with 3set fractures with pockets of inclined fracture (52^0 dip at 8.00-8.75m, 75^0 dip at 20.75-21.50m, 75^0 dip at 21.50-22.25m) and pockets of vertical fracture at 14.75-15.50m, 20.00-20.75m. Open fracture surfaces are apparently planar, slightly rough and altered.

Description of Core: Recovered core occurs as discontinuous (up to 8.00m) then continuous framework. Cores are mostly in lengths of 30-100mm with locally 100-200mm at 23.75-24.50m.

Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.

The formation rock is high to highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock

particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 96

(00.00 – 02.80)m: Overburden.

(02.80 – 11.00)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge.

(11.00 – 30.00)m: **Rock Description**: Highly weathered, brownish grey (up to 15.50m) followed by slightly weathered, light grey, foliated, fine grains are tightly compact **Granite schist**.
Rock Properties: Hard and strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal with 3set fractures. Open fracture surfaces are non-planar, rough and altered (up to 15.50m) to slightly altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm with <30mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is high to slightly weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 97

(00.00 – 02.60)m: Overburden.

(02.60 – 10.75)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge with remnants of highly weathered, core pieces at 5.75-6.50m.

(10.75 – 25.00)m: **Rock Description**: Moderate weathered, brownish white, coarse grains are tightly compact **Granite**.
Rock Properties: Hard and strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal with vertical fractures at 24.25-25.00m and inclined fractures (72^0 dip at 21.25-22.00m, 60^0 dip at 22.75-23.50m). Open fracture surfaces are non-planar, rough and slightly altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 98

(00.00 – 02.60)m: Overburden.

(02.60 – 11.50)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge with remnants of highly weathered, core pieces of Hornblende schist at 7.00-7.75m.

(16.00 – 16.75)m:

(11.50 – 20.00)m: **Rock Description**: Moderate to slightly weathered, light grey, indistinctly foliated, fine grains are tightly compact **Granite schist**.
Rock Properties: Hard and strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal with 3set fractures. Open fracture surfaces are non-planar, rough and slightly altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm with <30mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderate to slightly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 99

(00.00 – 03.40)m: Overburden.

(03.40 – 05.50)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge.

(05.50 – 25.00)m: **Rock Description**: Highly weathered, dark greenish brown, indistinctly foliated, fine to medium grains are densely compact **Hornblende schist**.
Rock Properties: Hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fractures. Open fracture surfaces are non-planar, rough and highly altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 100

(00.00 – 04.00)m: Overburden.

(04.00 – 20.50)m: Completely weathered, decomposed and disintegrated rock fragments, with pockets of highly weathered, medium to fine grained, brownish grey **Granite** at 6.25-7.75m, 9.25-10.00m, 10.75-15.25m..

(20.50 – 30.00)m: **Rock Description**: Moderately weathered, light grey, massive, fine to medium grains are densely compact **Granite**.
Rock Properties: Hard and strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fractures with rare vertical fractures at 14.50-15.25m, 22.75-23.50m depth. Open fracture surfaces are non-planar, rough and slightly altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 101

(00.00 – 03.60)m: Overburden.
(03.60 – 04.00)m: Boulder of quartzite.
(04.00 – 13.00)m: Completely weathered, decomposed and disintegrated rock fragments
(16.00 – 16.75)m: collected as sludge with remnants of highly weathered, brownish grey Quartz-biotite schist at 3.60-4.00m, 9.25-10.00m and 11.25-12.25m.
(13.00 – 30.00)m: **Rock Description**: Moderately weathered, light grey, indistinctly foliated, medium to fine grains are moderately compact **Quartz-biotite schist**.
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly 3-sets of fracture. Open fracture surfaces are non- planar, rough and altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly to moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 102

(00.00 – 02.40)m: Overburden.
(02.40 – 09.00)m: Completely weathered, decomposed and disintegrated rock fragments collected as sludge
(09.00 – 30.00)m: **Rock Description**: Moderately to slightly weathered, light grey (up to 27.75m) to brownish grey, indistinctly foliated, medium grains are moderately compact **Quartz-biotite schist**.
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (up to 27.75m, >15 nos./m) to closely spaced fractures (15-8 nos/m). Dominantly 3-sets with horizontal fracture (up to 27.75m) followed by horizontal fracture. Open fracture surfaces are non- planar, rough and slightly altered.

Description of Core: Recovered core occurs as discontinuous (up to 27.75m) followed by continuous framework. Cores are mostly in lengths of 30-100mm with 100-200mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderate to slightly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 103

(00.00 – 02.50)m: Overburden.

(02.50 – 10.75)m: Completely weathered, decomposed and disintegrated rock fragments, with pockets of highly weathered, medium to fine grained, brownish grey **Hornblende schist** at 08.50-10.00m.

(10.75 – 30.00)m: **Rock Description**: Highly (up to 10.50m) to moderately weathered, light grey, massive, fine to medium grains are densely compact **Granite**.
Rock Properties: Hard and strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fractures with rare vertical fractures at 15.25-16.00m depth. Open fracture surfaces are non-planar, rough and slightly altered.
Description of Core: Recovered core occurs as discontinuous (up to 04.50m) to continuous framework. Cores are mostly in lengths of 30-100mm with pockets of 100-200mm pieces at 16.00-16.75m.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is high to moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 104

(00.00 – 03.30)m: Overburden.

(03.30 – 13.00)m: Completely weathered, decomposed and disintegrated rock fragments, with pockets of highly weathered, medium to fine grained, brownish grey **Hornblende schist** at 03.30-04.00m, 09.25-10.00m.

(13.00 – 25.00)m: **Rock Description**: Highly weathered, brownish grey, indistinctly foliated, fine to medium grains are densely compact **Hornblende schist**.
Rock Properties: Hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fractures. Open fracture surfaces are non-planar, rough and altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 105

(00.00 – 02.00)m: Overburden.

(02.00 – 12.50)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge with remnants of highly weathered, medium to fine grained, brownish grey, rock fragments of **Hornblende schist** at 05.00-05.75m, 07.25-08.00m.

(12.50 – 25.00)m: **Rock Description**: Highly weathered, brownish grey, indistinctly foliated, fine to medium grains are moderately compact, **Quartzo feldspathic Gneiss**.
Rock Properties: Hard and moderately strong rock.

Structural Condition: Very closely spaced fractures. Dominantly 3-sets of fractures. Open fracture surfaces are non- planar, rough and altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm pieces.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is completely to highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 106

(00.00 – 01.80)m: Overburden.

(01.80 – 10.00)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge.

(10.00 – 30.00)m: **Rock Description**: Highly weathered, yellowish brown (up to 19.75m) followed by slightly weathered, blackish grey, foliated, fine to medium grains are moderate (up to 19.75m) followed by tightly compact **Hornblende schist**.
Rock Properties: Hard and moderately strong rock.

Structural Condition: Very closely spaced (up to 25.00m, >15 nos./m) followed by closely spaced fractures (15-8 nos/m). Dominantly horizontal with inclined fractures (55^0 dip at 27.25-28.00m) and vertical fracture at 21.25-22.00m depth. Open fracture surfaces are non-planar, rough and altered (up to 19.75m) followed by slightly altered.
Description of Core: Recovered core occurs as discontinuous (up to 21.25m) then continuous framework. Cores are mostly in lengths of 30-100mm with few 100-200mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.

The formation rock is highly to slightly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 107

(00.00 – 00.20)m: Overburden.

(00.20 – 12.00)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge with remnants of highly weathered, Hornblende schist at 6.00-6.75m depth.

(12.00 – 20.00)m: **Rock Description**: Highly weathered, yellowish brown to light brown, indistinctly foliated, fine grains are moderately compact **Hornblende schist**.
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal with 3set fractures. Open fracture surfaces are non-planar, rough and highly altered (up to 16.50m) to slightly altered.
Description of Core: Recovered core occurs as discontinuous (up to 16.50m) to continuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 108

(00.00 – 02.60)m: Overburden.

(02.60 – 06.75)m: Completely weathered, decomposed and disintegrated rock particles
(08.25 – 09.75)m: collected as sludge.

(06.75 – 25.00)m: **Rock Description**: Highly weathered, yellowish brown (up to 12.00m) to blackish grey, indistinctly foliated, fine grains are moderate to tightly compact **Hornblende biotite schist**.
Rock Properties: Moderately hard to hard and strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal with 3set fractures with locally vertical fracture at 19.50-20.25m. Open fracture surfaces are non-planar, rough and slightly altered.
Description of Core: Recovered core occurs as discontinuous (up to 16.50m) to continuous framework. Cores are mostly in lengths of 30-100mm with locally100-200mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 109

(00.00 – 03.50)m: Overburden.

(03.50 – 08.00)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge.

(08.00 – 25.00)m: **Rock Description**: Highly weathered, yellowish brown, indistinctly foliated, fine to medium grains are densely compact **Granite schist**.
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fractures. Open fracture surfaces are non-planar, rough and highly altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 110

(00.00 – 01.50)m: Overburden.

(01.50 – 21.75)m: Completely weathered, decomposed and disintegrated rock fragments collected as sludge.

(21.75 – 30.00)m: **Rock Description**: Moderately weathered, brownish grey, indistinctly foliated, medium to fine grains are moderately compact **Granite schist**.
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fracture with pockets of vertical fracture at 28.50-29.25m depth. Open fracture surfaces are non- planar, rough and slightly altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 111

(00.00 – 02.00)m: Overburden.

(02.00 – 05.00)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge.

(05.00 – 30.00)m: **Rock Description**: Highly weathered, yellowish brown (up to 16.25m) to dark grey, indistinctly foliated, medium to fine grains are tightly compact **Granite schist**.

Rock Properties: Moderately hard and moderately strong (up to 16.25m) to hard and strong rock.
Completely weathered, decomposed and disintegrated rock fragments collected as sludge at (11.75-14.75) m depth.

Structural Condition: Very closely spaced (>15 nos./m up to 20.75m) to closely spaced (15-8 nos/m) fractures. Dominantly 3-sets of fracture. Open fracture surfaces are non- planar, rough and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm up to 20.00m, followed by mostly 100-200mm in sizes.
Rock Mass Structure: The rock mass is very poor to poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 112

(00.00 – 02.50)m: Overburden.

(02.50 – 09.25)m: Completely weathered, decomposed and disintegrated rock fragments collected as sludge with remnants of highly weathered, brownish grey Quartz-biotite schist at 5.50-6.25m.

(09.25 – 30.00)m: **Rock Description**: Highly (up to 19.75m) to slightly weathered, brownish grey to light grey, indistinctly foliated, medium to fine grains are tightly compact **Quartz-biotite schist**.
Rock Properties: Moderately hard and moderately strong (up to 19.75m) to hard and strong rock.
Completely weathered, decomposed and disintegrated rock fragments collected as sludge at (13.75-16.75) m depth.

Structural Condition: Very closely spaced (>15 nos./m up to 25.75m) to closely spaced (15-8 nos/m) fractures. Dominantly 3-sets of fracture. Open fracture surfaces are non- planar, rough and altered (up to 19.75m) to almost clean.
Description of Core: Recovered core occurs as discontinuous (up to 21.25m) to continuous framework. Cores are mostly in lengths of 30-100mm mixed with rare 100-200mm pieces upto 27.25m, followed by mostly 100-200mm pieces..
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly to slightly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 113

(00.00 – 01.75)m: Overburden.

(01.75 – 09.25)m: Completely weathered, decomposed and disintegrated rock fragments collected as sludge with remnants of highly weathered, brownish grey

core pieces at 7.75-8.50m.

(09.25 – 30.00)m: **Rock Description**: Highly weathered, brownish grey, fine grains are moderately compact (up to 19.75m) followed by slightly weathered, blackish grey, indistinctly foliated, medium to fine grains are tightly compact **Quartz-biotite schist**.
Rock Properties: Moderately hard and moderately strong (up to 19.75m) to hard and strong rock.

Structural Condition: Very closely spaced (>15 nos./m up to 19.75m) to closely spaced (15-8 nos/m) fractures. Dominantly horizontal with inclined fracture (42^0dip at 20.50-21.25m). Open fracture surfaces are planar, slightly rough and altered (up to 19.75m) to slightly altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm mixed with rare 100-200mm pieces.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly to moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 114

(00.00 – 02.50)m: Overburden.

(02.50 – 06.25)m: Completely weathered, decomposed and disintegrated rock fragments collected as sludge.

(06.25 – 30.00)m: **Rock Description**: Highly weathered, brownish grey, indistinctly foliated, medium to fine grains are moderately compact **Hornblende schist**.
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely to closely spaced (>15 to 15-8 nos./m) fractures. Dominantly horizontal fracture. Open fracture surfaces are non- planar, rough and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm mixed with rare 100-200mm at 08.50-09.25m depth.
Rock Mass Structure: The rock mass is very poor to poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 115

(00.00 – 03.80)m: Overburden.

(03.80 – 20.30)m: Completely weathered, decomposed and disintegrated rock fragments collected as sludge with remnants of highly weathered, Hornblende Schist at 18.05-18.80m.

(20.30 – 25.00)m: **Rock Description**: Highly weathered, brownish grey, indistinctly foliated, medium to fine grains are moderately compact **Hornblende schist**.
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely to closely spaced (>15 to 15-8 nos./m) fractures. Dominantly horizontal fracture. Open fracture surfaces are non- planar, rough and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm mixed with rare 100-200mm at places.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 116

(00.00 – 03.50)m: Overburden.

(03.50 – 18.50)m: Completely weathered, decomposed and disintegrated rock fragments collected as sludge with pockets of highly weathered, greyish white Granite Schist pieces at 11.75-12.50m, 14.00-15.50m, 16.25-17.00m..

(18.50 – 25.00)m: **Rock Description**: Moderately weathered, greyish white, indistinctly foliated, medium grains are moderately compact **Granite schist**.
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal with 3set fracture. Open fracture surfaces are non- planar, rough and slightly altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly to moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 117

(00.00 – 03.50)m: Overburden.

(03.50 – 20.00)m: **Rock Description**: High (up to 14.00m) to moderately weathered, brownish grey, indistinctly foliated, fine grains are moderately compact **Hornblende schist**.
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely to closely spaced (>15 to 15-8 nos./m) fractures. Dominantly horizontal fracture. Open fracture surfaces are non- planar, slightly rough and altered.
Description of Core: Recovered core occurs as discontinuous (up to

5.00m) followed by continuous framework. Cores are mostly in lengths of 30-100mm mixed with rare 100-200mm.
Rock Mass Structure: The rock mass is very poor to poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly to moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 118

(00.00 – 02.50)m: Overburden.

(02.50 – 07.00)m: Completely weathered, decomposed and disintegrated rock fragments collected as sludge.

(07.00 – 20.00)m: **Rock Description**: Highly weathered, yellowish white, indistinctly foliated, fine grains are loosely compacted compact **Hornblende Schist** (upto13.75m) followed by moderately weathered, pinkish brown, medium grains are moderately compact **Granite**.
Rock Properties: Moderately hard and moderately strong rock.
Completely weathered, decomposed and disintegrated rock fragments collected as sludge at 11.50-13.00m and 14.50-16.00m depth.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal with 3set fracture. Open fracture surfaces are non- planar, slightly rough and slightly altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 119

(00.00 – 02.90)m: Overburden.

(02.90 – 05.25)m: Completely weathered, decomposed and disintegrated rock fragments collected as sludge.

(05.25 – 20.05)m: Completely weathered, decomposed and disintegrated rock fragments collected as sludge with remnants of highly weathered, yellowish white, indistinctly foliated, fine grains are loosely compact **Hornblende Schist** at 6..00-9.75m depth.
Rock Properties: Medium soft and medium weak to moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly 3set of fracture. Open fracture surfaces are non- planar, slightly rough and altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 120

(00.00 – 02.70)m: Overburden.

(02.70 – 15.00)m: Completely weathered, decomposed and disintegrated rock fragments collected as sludge.

BH : 121

(00.00 – 06.50)m: Overburden.

(06.50 – 15.00)m: Completely weathered, decomposed and disintegrated, medium grained, brownish grey rock fragments, with remnants of highly weathered, brownish grey, medium grained loosely compacted **Hornblende schist** at (06.50-08.00) m, (13.25-15.00) m.
Rock Properties: Medium soft and weak rock.
Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fractures. Open fracture surfaces are non-planar, smooth and altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm and <30mm.

Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is completely to highly weathered and huge to complete amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result complete to huge amount of core loss occurred.

BH : 122

(00.00 – 07.00)m: Overburden.

(07.00 – 15.00)m: Completely weathered, decomposed and disintegrated, medium grained, brownish grey rock fragments, with remnants of highly weathered, brownish grey, medium grained, loosely compacted **Hornblende schist** at (13.75-14.50) m.
Rock Properties: Medium soft and weak rock.
Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fractures. Open fracture surfaces are non-planar, smooth and altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm and <30mm.

Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is completely to highly weathered and huge to complete amount of the rock mass is disintegrated. During drilling the

disintegrated rock particles between fracture planes have been removed by drill water. As a result complete to huge amount of core loss occurred.

BH : 123

(00.00 – 04.50)m: Overburden.

(04.50 – 08.25)m: Completely weathered, decomposed and disintegrated rock fragments collected as sludge.
(12.75 – 14.25)m:

(08.25 – 25.00)m: **Rock Description**: Highly to moderately weathered, brownish grey, indistinctly foliated, medium grains are moderately compact **Quartz-biotite-schist**.
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal with 3set fracture. Open fracture surfaces are non- planar, rough and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly to moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 124

(00.00 – 03.50)m: Overburden.

(03.50 – 20.00)m: **Rock Description**: Highly weathered, brownish grey, indistinctly foliated, medium to fine grains are moderately compact **Quartz-biotite-schist**.
Rock Properties: Moderately hard and moderately strong rock.
Completely weathered, decomposed and disintegrated rock fragments collected as sludge at 17.75-20.00m depth.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fracture. Open fracture surfaces are apparently planar, smooth to slightly rough and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 125

(00.00 – 03.80)m: Overburden.

(03.80 – 20.00)m: Highly weathered, brownish grey, fine grained, schistose, loose to moderately compact, **Hornblende schist** with pockets of moderately

weathered, pinkish grey, **Granite** pieces at 6.75-10.50m.
Rock Properties: Moderately hard and moderately strong rock.
Completely weathered, decomposed and disintegrated rock particles collected as sludge at 5.25-6.75m and 11.25-15.75m.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal with inclined fracture (52^0 dip at 18.75-19.50m). Open fracture surfaces are planar to non-planar, slightly rough and slightly altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm.

Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 126

(00.00 – 04.00)m: Overburden.

(04.00 – 15.00)m: Moderately weathered, brownish grey, medium to fine grained, schistose, moderately compacted, **Hornblende schist**.
Rock Properties: Moderately hard and moderately strong rock.
Completely weathered, decomposed and disintegrated rock particles collected as sludge at 4.75-5.50m.

Structural Condition: Very closely spaced (up to 13.00m, >15 nos./m) followed by closely spaced (15-8 nos/m) fractures. Dominantly horizontal fractures. Open fracture surfaces are planar to non-planar, slightly rough and slightly altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm and 100-200mm.

Rock Mass Structure: The rock mass is very poor with locally poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 127

(00.00 – 05.80)m: Overburden.

(05.80 – 20.00)m: Highly weathered, greenish brown, fine grained, schistose, loose to moderately compact, **Hornblende schist**.
Rock Properties: Moderately hard and moderately strong rock.
Completely weathered, decomposed and disintegrated rock particles collected as sludge at 12.50-14.75m and 16.25-18.50m.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fracture with pockets of inclined fractures (52^0 dip at 11.75-12.50m, 44^0 dip at 15.50-16.25m) are observed. Open fracture surfaces are planar to non-planar, slightly rough and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm with locally 100-200mm.

Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 128

(00.00 – 03.20)m: Overburden.

(03.20 – 20.00)m: Highly weathered, light yellowish grey (up to 16.75m) followed by slightly weathered, blackish grey, medium to fine grained, schistose, moderate (up to 16.75m) to tightly compact, **Granite biotite schist**.
Rock Properties: Moderately hard and moderately strong (up to 16.75m) followed by hard and strong rock.
Completely weathered, decomposed and disintegrated rock particles collected as sludge at 4.00-4.75m, 6.25-7.75m, 9.25-10.00m and 12.25-15.25m.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly 3set (up to 16.75m) followed by horizontal fracture. Open fracture surfaces are non-planar, rough and altered.
Description of Core: Recovered core occurs as discontinuous (up to 17.25m) followed by continuous framework. Cores are mostly in lengths of 30-100mm (up to 16.75m) followed by 100-200mm and few 100-300mm lengths.

Rock Mass Structure: The rock mass is very poor (up to 18.25m) followed by poor to fair quality.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly to slightly weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 129

(00.00 – 5.00)m: Overburden.

(05.00 – 20.00)m: Highly weathered, brownish grey, fine grained, foliated (70^0 dip), moderately compacted (up to 14.00m) followed by slightly weathered, blackish grey, fine grained, tightly compacted, **Granite Gneiss**.
Rock Properties: Moderately hard and moderately strong (up to 14.00m) followed by hard and strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal with few 3set fractures. Open fracture surfaces are planar to non-planar, slightly rough and slightly altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm and 100-200mm.

Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 130

(00.00 – 03.50)m: Overburden.

(03.50 – 08.75)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge

(08.75 – 30.00)m: Highly weathered, brownish grey, medium to fine grained, schistose, moderately compacted, **Hornblende schist**.
Rock Properties: Moderately hard and moderately strong rock.
Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal with 3set fractures. Open fracture surfaces are planar, slightly rough and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm.

Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 131

(00.00 – 06.80)m: Overburden.

(06.80 – 13.50)m: Completely weathered, decomposed and disintegrated rock fragments collected as sludge with remnants of highly weathered, brownish grey Quartz-biotite schist at 10.50-12.00m.

(13.50 – 25.00)m: **Rock Description**: Highly weathered, brownish grey (up to 18.00m) followed by slightly weathered, light grey, indistinctly foliated, medium to fine grains are moderate (up to 18.00m) followed by tightly compact **Quartz-biotite schist**.
Rock Properties: Moderately hard and moderately strong (up to 18.00m) followed by hard and strong rock.

Structural Condition: Very closely spaced (>15 nos./m up to 18.00m) to closely spaced (15-8 nos/m) fractures. Dominantly 3-sets of fracture (up to 18.00m) then horizontal fracture with locally vertical

fracture at . Open fracture surfaces are non- planar, rough and altered (up to 19.75m) to almost clean.
Description of Core: Recovered core occurs as discontinuous (up to 21.25m) to continuous framework. Cores are mostly in lengths of 30-100mm mixed with rare 100-200mm pieces upto 27.25m, followed by mostly 100-200mm pieces..
Rock Mass Structure: The rock mass is very poor to poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly to slightly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 132

(00.00 – 05.40)m: Overburden.

(05.40 – 30.00)m: Highly weathered, brownish grey (up to 22.50m) followed by moderately weathered, fine grained, schistose, moderately compacted, **Hornblende schist**.
Rock Properties: Moderately hard and moderately strong rock.
Completely weathered, decomposed and disintegrated rock particles collected as sludge at 8.25-9.00m, 9.75-10.50m, and 18.75-21.00m.depth.
Structural Condition: Very closely spaced (up to 18.75m, >15 nos./m) followed by closely spaced (15-8 nos/m) fractures. Dominantly horizontal with inclined fractures (55^0 dip at 26.25-27.00m) and locally vertical fracture at 23.25-24.00m. Open fracture surfaces are planar, slightly rough and slightly altered.
Description of Core: Recovered core occurs as discontinuous (up to 18.75m) followed by continuous framework. Cores are mostly in lengths of 30-100mm with locally 100-200mm.

Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly to moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 133

(00.00 – 03.00)m: Overburden.

(03.00 – 25.00)m: **(03.00 – 04.50)m:**
Highly weathered, pinkish grey, medium grained, moderately compact **Granite**.
(04.50 – 12.00)m:
Completely weathered, decomposed and disintegrated rock particles collected as sludge
(12.00 – 25.00)m:
Moderate to slightly weathered, blackish grey, medium to fine grained, tightly compact **Biotite Schist**.

Rock Properties: Hard and strong rock.
Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal with inclined fractures (45^0 - 55^0 dip at 15.00-17.25m) and locally vertical fracture at 19.50-20.25m. Open fracture surfaces are planar, slightly rough and slightly altered.
Description of Core: Recovered core occurs as discontinuous (up to 14.25m) followed by continuous framework. Cores are mostly in lengths of 30-100mm with locally 100-200mm.

Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly to moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 134

(00.00 – 03.00)m: Overburden.

(03.00 – 20.00)m: **(03.00 – 09.75)m:**
Slightly weathered, pinkish white, medium grained, indistinctly foliated, tightly compact **Granite Schist**.
Rock Properties: Hard and strong rock.
(09.75 – 20.00)m:
Moderately weathered, brownish grey, medium to fine grained, moderately compact, **Hornblende Schist**.
Completely weathered, decomposed and disintegrated rock particles collected as sludge at 15.00-18.75m depth.
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal with locally inclined fractures (45^0 - $55^{0)}$ and vertical fracture at 12.75-13.50m. Open fracture surfaces are non-planar, slightly rough and altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderately to slightly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 135

(00.00 – 03.00)m: Overburden.

(03.00 – 15.00)m: **Rock Description**: Completely weathered, decomposed and disintegrated rock fragments collected as sludge with remnants of highly weathered, pinkish grey, **Granite** at 7.50-10.50m.
Rock Properties: Moderately hard and moderately strong.

Structural Condition: Very closely spaced (>15 nos./m) fractures.

Dominantly 3-sets of fracture. Open fracture surfaces are non- planar, rough and altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 136

(00.00 – 03.50)m: Overburden.

(03.50 – 11.00)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge

(11.00 – 15.00)m: **(11.00 – 13.25)m:**
Moderately weathered, pinkish grey, fine grained, tightly compacted, **Quartzite.**
Rock Properties: Hard and strong rock.
(13.25 – 15.00)m:
Moderately weathered, brownish grey, fine grained, moderately compacted, **Hornblende schist**.
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly 3set fracture (up to 13.25m) followed by horizontal fracture. Open fracture surfaces are non-planar, rough and altered (up to 13.25m) followed by slightly altered.
Description of Core: Recovered core occurs as discontinuous (up to 13.25m) to continuous framework. Cores are mostly in lengths of 30-100mm.

Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 137

(00.00 – 02.80)m: Overburden.

(02.80 – 08.00)m: Completely weathered, decomposed and disintegrated rock particles

(11.75 – 15.00)m: collected as sludge

(08.00 – 11.75)m: Highly weathered, greyish white, medium grained, moderately compacted, **Granite**.
Rock Properties: Moderately hard and moderately strong rock.
Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal with 3set fractures. Open fracture surfaces are non-planar, slightly rough and slightly altered.
Description of Core: Recovered core occurs as continuous

framework. Cores are mostly in lengths of 30-100mm.

Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 138

(00.00 – 01.40)m: Overburden.

(01.40 – 13.25)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge with remnants of highly weathered, quartzite pieces at 2.75-5.00m depth.

(13.25 – 30.00)m: Highly weathered, brownish yellow (up to 19.00m) followed by moderately weathered, blackish grey, medium grained, moderately compacted, **Hornblende Schist**.
Rock Properties: Moderately hard and moderately strong rock.
Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal with 3set fractures. Open fracture surfaces are non-planar, rough and altered (up to 19.00m) to slightly altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm.

Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 139

(00.00 – 03.70)m: Overburden.

(03.70 – 11.25)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge

(11.25 – 25.00)m: Highly weathered, brownish grey, fine grained, schistose, loosely compacted, **Hornblende schist**.
Rock Properties: Moderately hard and moderately strong rock.
Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fractures. Open fracture surfaces are non-planar, slightly rough and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm.

Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result

huge amount of core loss occurred.

BH : 140

(00.00 – 03.50)m: Overburden.

(03.50 – 08.00)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge

(08.00 – 20.00)m: Highly weathered, greenish grey, fine grained, gneissose (80^0 dip), loose to moderately compacted, **Hornblende Schist**.
Rock Properties: Medium soft and medium weak to moderately hard and moderately strong rock.
Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly 3set with horizontal fractures. Open fracture surfaces are non-planar, slightly rough and altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm.

Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 141

(00.00 – 04.30)m: Overburden.

(04.30 – 08.75)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge

(08.75 – 20.00)m: Highly weathered, greenish grey, medium grained, schistose, moderately compacted, **Hornblende Schist**.
Rock Properties: Moderately hard and moderately strong rock.
Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fractures. Open fracture surfaces are non-planar, slightly rough and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm.

Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 142

(00.00 – 03.00)m: Overburden.

(03.00 – 08.25)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge

(08.25 – 20.00)m: Highly weathered, greenish grey (up to 15.00m) to brownish grey, fine grained, schistose, moderately compacted, **Hornblende Schist**.
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal with 3set fractures. Open fracture surfaces are planar, slightly rough and altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm.

Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 143

(00.00 – 02.50)m: Overburden.

(02.50 – 07.00)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge

(07.00 – 15.00)m: Highly weathered, brownish grey, fine grained, schistose, moderately compacted, **Hornblende Schist**.
Rock Properties: Moderately hard and moderately strong rock.
Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal with 3set fractures. Open fracture surfaces are planar, slightly rough and altered.
Description of Core: Recovered core occurs as discontinuous (up to 13.75m) followed by continuous framework. Cores are mostly in lengths of 30-100mm.

Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 144

(00.00 – 03.30)m: Overburden.

(03.30 – 05.50)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge

(05.50 – 15.00)m: Highly weathered, brownish grey, fine grained, schistose, loosely compact, **Hornblende schist**.
Rock Properties: Moderately hard and moderately strong rock.
Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fractures. Open fracture surfaces are non-planar, slightly rough and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm.

Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.

The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 145

(00.00 – 03.80)m: Overburden.

(03.80 – 09.00)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge

(09.00 – 20.00)m: Highly weathered, brownish grey, fine grained, schistose, loosely compacted, **Hornblende schist**.
Rock Properties: Moderately hard and moderately strong rock.
Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fractures. Open fracture surfaces are non-planar, slightly rough and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm.

Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 146

(00.00 – 03.30)m: Overburden.

(03.30 – 11.50)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge

(11.50 – 15.00)m: Highly weathered, brownish grey, fine grained, schistose, loosely compacted, **Hornblende schist**.
Rock Properties: Moderately hard and moderately strong rock.
Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fractures. Open fracture surfaces are non-planar, slightly rough and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm.

Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 147

(00.00 – 01.40)m: Overburden.

(01.40 – 03.50)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge.

(03.50 – 15.00)m: **(03.50 – 06.50)m:**

Moderately weathered, pinkish grey, medium to coarse grained, moderately compacted, **Granite**.
Rock Properties: Moderately hard and moderately strong rock.
(06.50 – 15.00)m:
Moderately weathered, brownish grey, medium grained, indistinctly gneissose, moderately compacted, **Hornblende Gneiss**.
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal with 3set fractures (up to 11.00m) followed by horizontal fracture. Open fracture surfaces are planar, rough and altered.
Description of Core: Recovered core occurs as discontinuous (up to 11.00m) followed by continuous framework. Cores are mostly in lengths of 30-100mm.

Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 148

(00.00 – 03.50)m: Overburden.

(03.50 – 20.00)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge with pockets of highly weathered, brownish grey, medium grained, gneissose (72^0 dip), moderately compacted, **Hornblende Gneiss** at 5.00-10.25m.
Rock Properties: Moderately hard and moderately strong rock.
Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal with vertical fracture (at 5.00-5.75m) and inclined fracture (75^0 dip at 5.75-6.50m, 69^0 dip at 7.25-8.00m). Open fracture surfaces are non-planar, rough and altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm.

Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 149

(00.00 – 03.25)m: Overburden.

(03.25 – 08.50)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge.

(08.50 – 15.00)m: Moderately weathered, blackish grey, fine grained, moderately compacted, **Hornblende schist**.

Rock Properties: Moderately hard and moderately strong rock.
Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal with 3set fractures and locally vertical fracture (). Open fracture surfaces are planar, slightly rough to smooth and slightly altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm with rarely 100-200mm.

Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 150

(00.00 – 03.20)m: Overburden.

(03.20 – 04.00)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge

(04.00 – 20.00)m: Highly weathered, brownish grey, fine grained, indistinctly gneissose, moderately compacted, **Hornblende Gneiss**.
Rock Properties: Moderately hard and moderately strong rock.
Completely weathered, decomposed and disintegrated rock particles collected as sludge at 8.50-12.25m and 14.50-17.50m.
Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly 3set with horizontal fractures. Open fracture surfaces are non-planar, rough and altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm with <30mm.

Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 151

(00.00 – 03.00)m: Overburden.

(03.00 – 12.00)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge

(12.00 – 15.00)m: Highly weathered, brownish grey, medium grained, schistose, moderately compacted, **Hornblende schist**.
Rock Properties: Moderately hard and moderately strong rock.
Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly 3set fractures. Open fracture surfaces are non-planar, slightly rough and altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm with <30mm.

Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 152

(00.00 – 02.60)m: Overburden.

(02.60 – 15.00)m: Highly weathered, brownish grey, fine grained, moderately compacted, **Granite schist**.
Rock Properties: Moderately hard and moderately strong rock.
Completely weathered, decomposed and disintegrated rock particles collected as sludge at 7.25-9.25m.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal with vertical fracture (at 06.25-.7.00m, 12.25-13.00m). Open fracture surfaces are non-planar, slightly rough and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 153

(00.00 – 03.00)m: Overburden.

(03.00 – 15.00)m: Moderately weathered, brownish white, medium grained, tightly compacted, **Granite schist**.
Rock Properties: Hard and strong rock.
Structural Condition: Closely spaced (15-8 nos./m) fractures. Dominantly horizontal with vertical fracture (at 11.25-12.00m, 12.75-13.50m) and rarely inclined fracture (58^0 dip at 13.50-14.25m). Open fracture surfaces are non-planar, rough and slightly altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm and 100-200mm.

Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 154

(00.00 – 06.40)m: Overburden.

(06.40 – 13.75)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge.

(13.75 – 15.00)m: Highly weathered, brownish grey, fine grained, loosely compacted **Hornblende schist**.
Rock Properties: Soft and weak rock.
Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly 3set with horizontal fractures. Open fracture surfaces are planar, smooth and altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm and <30mm.

Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 155

(00.00 – 02.60)m: Overburden.

(02.60 – 20.00)m: Highly weathered, brownish grey, fine grained, schistose, loosely compacted, **Hornblende schist**.
Rock Properties: Medium soft and medium weak to moderately strong rock.
Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal with 3set fractures. Open fracture surfaces are apparently planar, slightly rough and altered.
Description of Core: Recovered core occurs as discontinuous (up to 15.25m) followed by continuous framework. Cores are mostly in lengths of 30-100mm with locally 100-200mm in length at 19.00-20.00m.

Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 156

(00.00 – 04.50)m: Overburden.

(04.50 – 15.00)m: Highly weathered, brownish grey, fine grained, indistinctly schistose, moderately compacted **Hornblende schist**.
Rock Properties: Moderately hard and moderately strong rock.
Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fractures. Open fracture surfaces are non-planar, slightly rough and altered.
Description of Core: Recovered core occurs as discontinuous

framework. Cores are mostly in lengths of 30-100mm.

Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 157

(00.00 – 04.50)m: Overburden.

(04.50 – 06.75)m: Completely weathered, decomposed and disintegrated rock fragments of Sandstone.

(06.75 – 20.00)m: **Rock Description**: Moderately weathered, brownish grey (up to 10.50m) followed by slightly weathered, pinkish grey, medium to fine grains are tightly compact, **Granite**.
Rock Properties: Hard and strong rock.

Structural Condition: Very close (up to 10.50m, >15 nos./m) to closely spaced (15-8 nos/m) fractures. Dominantly horizontal fractures with locally inclined fractures (75^0 dip at 9.75-10.50m, 56^0 dip at 14.25-15.00m). Open fracture surfaces are non-planar, rough and slightly altered.
Description of Core: Recovered core occurs as discontinuous (up to 10.50m) followed by continuous framework. Cores are mostly in lengths of 30-100mm and 100-200mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderately weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 158

(00.00 – 03.60)m: Overburden.

(03.60 – 15.00)m: Completely weathered, decomposed and disintegrated rock fragments, with pockets of highly weathered, light grey, fine grains are thinly bedded **Sandstone** at 07.25-08.00m.

Structural Condition: Very closely spaced fractures. Dominantly 3-sets of fractures. Open fracture surfaces are non- planar, rough and altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm pieces.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is complete to highly weathered and complete to huge amount of the rock mass is disintegrated. During drilling the

disintegrated rock particles between fracture planes have been removed by drill water. As a result complete to huge amount of core loss occurred.

BH : 159

(00.00 – 02.25)m: Overburden.

(02.25 – 06.00)m: Completely weathered, decomposed and disintegrated rock fragments of Sandstone.

(06.00 – 10.00)m: **Rock Description**: Highly weathered, yellowish grey to light grey, bedded, fine to medium grains are loosely compact **Sandstone**.
Rock Properties: Medium soft and weak rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fractures. Open fracture surfaces are planar, smooth and altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 160

(00.00 – 06.00)m: Overburden.

(06.00 – 07.50)m: Completely weathered, decomposed and disintegrated rock fragments of Sandstone.

(07.50 – 10.00)m: **Rock Description**: Highly weathered, yellowish grey with brown shades, bedded, fine grains are loosely compact **Sandstone**.
Rock Properties: Medium soft and weak rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fractures. Open fracture surfaces are planar, smooth and altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 161

(00.00 – 04.60)m: Overburden.

(04.60 – 10.00)m: **Rock Description**: Highly weathered, yellowish grey to light grey, bedded, fine to medium grains are loosely compact **Sandstone**.
Rock Properties: Medium soft and weak rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fractures. Inclined (43°) fracture at 08.00m depth. Open fracture surfaces are planar, smooth and altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 162

(00.00 – 06.50)m: Overburden.

(06.50 – 10.00)m: Completely weathered, decomposed and disintegrated rock fragments, with pockets of highly weathered, yellowish grey, very fine grains are laminated **Shale** at 08.00-08.75m.

Structural Condition: Very closely spaced fractures. Dominantly 3-sets of fractures. Open fracture surfaces are non- planar, rough and altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm pieces.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is completely to highly weathered and complete to huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result complete to huge amount of core loss occurred.

BH : 163

(00.00 – 06.50)m: Overburden.

(06.50 – 10.00)m: Completely weathered, decomposed and disintegrated, medium grained, brownish grey rock fragments of **Sandstone**.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is completely weathered and complete amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result complete amount of core loss occurred.

BH : 164

(00.00 – 03.60)m: Overburden.

(03.60 – 10.00)m: **Rock Description**: Highly weathered, brownish grey to light grey, laminated, very fine grains are loosely compact **Shale**.
Rock Properties: Soft and weak rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures.

Dominantly horizontal fractures. Open fracture surfaces are planar, smooth and altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 165

(00.00 – 04.00)m: Overburden.

(04.00 – 15.00)m: **Rock Description**: Highly weathered, yellowish grey to light grey, medium bedded, fine to medium grains are moderately to loosely compact **Sandstone**.
Rock Properties: Soft and weak rock.
Completely weathered, decomposed and disintegrated rock fragments collected as sludge at 10.00-11.50m, 13.00-15.00m depth.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fractures. Open fracture surfaces are planar, smooth and altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 166

(00.00 – 04.70)m: Overburden.

(04.70 – 10.00)m: **Rock Description**: Highly weathered, brownish grey to light grey, laminated, very fine grains are loosely compact **Shale**.
Rock Properties: Soft and weak rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fractures. Open fracture surfaces are planar, smooth and altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 167

(00.00 – 03.75)m: Overburden.

(03.75 – 15.00)m: **Rock Description**: Highly weathered, yellowish grey to light grey, medium bedded, fine to medium grains are moderately compact **Sandstone**.
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fractures. Open fracture surfaces are planar, smooth and altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 168

(00.00 – 03.50)m: Overburden.

(03.50 – 07.25)m: Completely weathered, decomposed and disintegrated rock fragments, with remnants of highly weathered, coarse grained, brownish grey Granite gneiss at 04.25-05.00m depth.

(07.25 – 15.00)m: **(07.25-11.75)m:**
Rock Description: Highly weathered, pinkish brown, indistinctly foliated, medium to coarse grains are moderately compact **Granite gneiss**.
Rock Properties: Moderately hard and moderately strong rock.
(11.75-15.00)m:
Rock Description: Highly weathered, brownish grey, indistinctly foliated, fine to medium grains are moderately compact **Hornblende schist**.
Rock Properties: Moderately hard and moderately strong rock.
Completely weathered, decomposed and disintegrated rock fragments of Hornblende schist at 13.25-15.00m depth.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly 3-sets of fractures. Open fracture surfaces are non-planar, rough and highly altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 169

(00.00 – 03.50)m: Overburden.

(03.50 – 08.75)m: Completely weathered, decomposed and disintegrated Hornblende schist.

(08.75 – 10.00)m: **Rock Description**: Highly weathered, brownish grey, indistinctly foliated, fine to medium grains are moderately compact **Hornblende schist**.
Rock Properties: Moderately soft and weak rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly 3-sets of fractures. Open fracture surfaces are non-planar, rough and highly altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 170

(00.00 – 04.30)m: Overburden.

(04.30 – 10.00)m: **Rock Description**: Highly weathered, dark greenish grey, indistinctly foliated, medium to fine grains are loose to moderately compact **Hornblende schist**.
Rock Properties: Moderately soft to moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fractures. Open fracture surfaces are non-planar, rough and altered.
Description of Core: Recovered core occurs as discontinuous (up to 06.50m) to continuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 171

(00.00 – 05.50)m: Overburden.

(05.50 – 15.00)m: Completely weathered, decomposed and disintegrated rock fragments, with pockets of highly weathered, medium grained, **Sandstone** at 07.00-10.75m depth.
Structural Condition: Very closely spaced fractures. Dominantly 3-sets of fractures. Open fracture surfaces are non- planar, rough and altered.

Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm pieces.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is complete to highly weathered and complete to huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result complete to huge amount of core loss occurred.

BH : 172

(00.00 – 05.80)m: Overburden.

(05.80 – 10.00)m: **Rock Description**: Highly weathered, brownish grey, medium bedded, fine to medium grains are moderately compact **Sandstone**.
Rock Properties: Moderately soft and weak rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fractures. Open fracture surfaces are planar, smooth and altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 173

(00.00 – 08.80)m: Overburden.

(08.80 – 10.00)m: **Rock Description**: Highly weathered, brownish grey, medium bedded, fine to medium grains are moderately compact **Sandstone**.
Rock Properties: Moderately soft and weak rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fractures. Open fracture surfaces are planar, smooth and altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 174

(00.00 – 06.00)m: Overburden.

(06.00 – 09.00)m: Completely weathered, decomposed and disintegrated Sandstone.

(09.00 – 15.00)m: **Rock Description**: Highly weathered, yellowish grey, medium bedded, fine to medium grains are moderately compact **Sandstone**.
Rock Properties: Moderately soft and weak rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fractures. Open fracture surfaces are planar, smooth and altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 175

(00.00 – 06.40)m: Overburden.

(06.40 – 07.75)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge.

(07.75 – 10.00)m: **Rock Description**: Moderately weathered, light grey, foliated (70°), medium grains are moderately compact **Quartz-biotite gneiss**.
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly 3-sets (up to 09.25m) to dominantly horizontal fracture. Open fracture surfaces are non- planar, rough and slightly altered.
Description of Core: Recovered core occurs as discontinuous (up to 09.25m) to continuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 176

(00.00 – 06.20)m: Overburden.

(06.20 – 07.00)m: Completely weathered, decomposed and disintegrated Hornblende gneiss.

(07.00 – 15.00)m: **Rock Description**: Highly weathered, brownish grey, indistinctly foliated, medium to fine grains are moderately compact **Hornblende gneiss**.
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures.

Dominantly 3-sets of fractures. Open fracture surfaces are non-planar, rough and highly altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 177

(00.00 – 05.70)m: Overburden.

(05.70 – 06.50)m: Completely weathered, decomposed and disintegrated Hornblende gneiss.

(06.50 – 10.00)m: **Rock Description**: Highly weathered, brownish grey, indistinctly foliated, medium to fine grains are moderately compact **Hornblende gneiss**.
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly 3-sets of fractures. Open fracture surfaces are non-planar, rough and highly altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 178

(00.00 – 06.30)m: Overburden.

(06.30 – 10.00)m: **Rock Description**: Highly weathered, brownish grey, indistinctly foliated, medium to fine grains are moderately to densely compact **Hornblende gneiss**.
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly 3-sets of fractures. Open fracture surfaces are non-planar, rough and highly altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result

huge amount of core loss occurred.

BH : 179

(00.00 – 06.10)m: Overburden.

(06.10 – 07.00)m: Completely weathered, decomposed and disintegrated Granite gneiss.

(07.00 – 15.00)m: **Rock Description**: Highly (up to 11.50m) to moderately weathered, brownish grey, indistinctly foliated, medium grains are moderately compact **Granite gneiss**.
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly 3-sets of fractures (up to 11.50m) to dominantly horizontal fractures. Open fracture surfaces are non-planar, rough and highly altered (up to 11.50m) to slightly altered.
Description of Core: Recovered core occurs as discontinuous (up to 11.50m) to continuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly to moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 180

(00.00 – 06.20)m: Overburden.

(06.20 – 10.00)m: **Rock Description**: Highly weathered, yellowish grey, medium bedded, medium grains are moderately compact **Sandstone**.
Rock Properties: Moderately soft and weak rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fractures. Open fracture surfaces are planar, smooth and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm, with pockets of 100-200mm pieces at 07.75-08.50m, 09.25-10.00m.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 181

(00.00 – 06.50)m: Overburden.

(06.50 – 10.00)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge.

BH : 182

(00.00 – 02.00)m: Overburden.

(02.00 – 10.00)m: Completely weathered, decomposed and disintegrated rock fragments, with pockets of highly weathered, brownish grey, medium grains are indistinctly foliated **Hornblende schist** at 02.00-04.25m, 08.75-10.00m.

Structural Condition: Very closely spaced fractures. Dominantly 3-sets of fractures. Open fracture surfaces are non- planar, rough and altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm pieces.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is completely to highly weathered and complete to huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result complete to huge amount of core loss occurred.

BH : 183

(00.00 – 03.00)m: Overburden.

(03.00 – 15.00)m: **Rock Description**: Moderately (up to 12.00m) to slightly weathered, brownish grey (up to 12.00m) to light grey, foliated (70°), medium grains are densely compact **Granite gneiss**.
Rock Properties: Hard and strong rock.

Structural Condition: Very closely spaced (>15 nos./m up to 11.25m) to closely (15-8 nos/m) spaced fractures. Dominantly horizontal fractures with rare inclined fractures (67° at 9.00-9.75m, 75° at 12.00-12.75m). Open fracture surfaces are non-planar, rough and altered (up to 12.00m) to almost fresh.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm up to 11.25m, followed by mostly 100-200mm mixed with 30-100mm.
Rock Mass Structure: The rock mass is very poor to poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderate to slightly weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 184

(00.00 – 03.50)m: Overburden.

(03.50 – 05.75)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge.

(05.75 – 10.00)m: **Rock Description**: Highly weathered, brownish grey, indistinctly foliated, medium grains are densely compact **Granite gneiss**.
Rock Properties: Hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly 3-sets of fractures (up to 07.25m) to dominantly horizontal fractures. Open fracture surfaces are non-planar, rough and altered .
Description of Core: Recovered core occurs as discontinuous (up to 07.25m) to continuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 185

(00.00 – 06.00)m: Overburden.

(06.00 – 10.00)m: **Rock Description**: Highly (up to 08.25m) to moderately weathered, brownish grey, foliated (60°), medium grains are densely compact **Granite gneiss**.
Rock Properties: Hard and strong rock.

Structural Condition: Very closely spaced (>15 nos./m fractures. Dominantly horizontal fractures with rare inclined fractures (52° at 6.00-6.75m, 55° at 09.00-10.00m). Few vertical fractures at 06.00-06.75m, 09.00-10.00m depth. Open fracture surfaces are non-planar, rough and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly to moderately weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 186

(00.00 – 05.00)m: Overburden.

(05.00 – 10.00)m: **Rock Description**: Highly (up to 08.00m) to moderately weathered, brownish grey, foliated (65°), medium grains are densely compact **Hornblende schist**.
Rock Properties: Hard and Moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m fractures. Dominantly horizontal fractures. Open fracture surfaces are non-planar, rough and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly to moderately weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH : 187

(00.00 – 04.00)m: Overburden.

(04.00 – 07.75)m: Completely weathered, decomposed and disintegrated Hornblende schist.

(07.75 – 10.00)m: **Rock Description**: Highly weathered, dark brownish grey, indistinctly foliated, medium to fine grains are loose to moderately compact **Hornblende schist**.
Rock Properties: Moderately soft and weak rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fractures. Open fracture surfaces are non-planar, rough and altered.
Description of Core: Recovered core occurs as discontinuous (up to 06.50m) to continuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 188

(00.00 – 03.80)m: Overburden.

(03.80 – 10.50)m: Completely weathered, decomposed and disintegrated Hornblende schist.

(10.50 – 15.00)m: **Rock Description**: Highly weathered, brownish grey, indistinctly foliated, fine grains are moderately compact **Hornblende schist**.
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly 3-sets of fractures. Open fracture surfaces are non-planar, rough and highly altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 189

(00.00 – 05.00)m: Overburden.

(05.00 – 20.00)m: **Rock Description**: Highly weathered, yellowish brown, indistinctly foliated, medium grains are moderately compact **Hornblende schist**.
Rock Properties: Moderately hard and moderately strong rock.
Completely weathered, decomposed and disintegrated rock particles collected as sludge at 8.50-10.75m and 13.00-20.00m depth.
Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal with 3-sets of fractures. Open fracture surfaces are non-planar, rough and altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 190

(00.00 – 03.50)m: Overburden.

(03.50 – 20.00)m: **Rock Description**: Highly weathered, yellowish brown, fine to medium grains are loosely compact **Sandstone**.
Rock Properties: Medium soft and medium weak to moderately strong rock.
Completely weathered, decomposed and disintegrated rock particles collected as sludge at 9.50-11.75m.

Structural Condition: Very closely spaced (up to 13.25m, >15 nos./m) then closely spaced (15-8 nos/m) fractures. Dominantly horizontal fracture. Open fracture surfaces are planar, smooth and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm (up to 13.25m) followed by 30-100mm and 100-200mm.
Rock Mass Structure: The rock mass is very poor (up to 13.25m) followed by poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 191

(00.00 – 02.10)m: Overburden.

(02.10 – 10.00)m: **Rock Description**: Moderately weathered, reddish brown (upto 2.85m) to brownish grey, fine grains are moderately compact **Sandstone**.
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal with inclined fractures (55^0 dip 8.80-8.85m, 59^0 dip 8.85-9.60m). Open fracture surfaces are planar, slightly rough to smooth and altered.
Description of Core: Recovered core occurs as discontinuous (upto 6.00m) followed by continuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 192

(00.00 – 11.25)m: Overburden.
(11.25 – 12.00)m: Completely weathered, decomposed and disintegrated rock particles
(12.75 – 13.50)m: collected as sludge.
(11.25 – 15.00)m: **Rock Description**: Highly weathered, greyish black colour, very fine grains are loosely compact **Carbonaceous Shale and coal**.
Rock Properties: Medium soft and medium weak to moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal with 3set fractures. Open fracture surfaces are non-planar, slightly rough and slightly altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH : 193

(00.00 – 06.30)m: Overburden.
(06.30 – 10.00)m: Completely weathered, decomposed and disintegrated rock particles collected as sludge.

BH : 194

(00.00 – 11.10)m: Overburden.
(11.10 – 15.00)m: **Rock Description**: Slightly weathered, zed black colour, very fine grains are loosely compact **Carbonaceous Shale and coal**.
Rock Properties: Medium soft and medium weak to moderately strong rock.

Structural Condition: Closely spaced (15-8 nos./m) fractures. Dominantly horizontal with inclined fracture (45^0 at 13.25-14.00m). Open fracture surfaces are non-planar, slightly rough and slightly

altered to clean.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm and 100-200mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is slightly weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

IBH : 24

(00.00 – 04.75)m: Overburden.

(04.75 – 20.00)m: **Rock Description**: Completely to highly weathered, brownish grey, indistinctly foliated, fine grains are moderately compact **Hornblende schist**.
Rock Properties: Moderately hard and moderately strong rock.
Completely weathered, decomposed and completely disintegrated, fine to medium grained Hornblende schist at 4.75-5.50m, 6.25-7.00m, 13.75-16.75m depth.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly 3-sets of fractures. Open fracture surfaces are non-planar, rough and altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

IBH : 25

(00.00 – 03.00)m: Overburden.

(03.00 – 20.00)m: **Rock Description**: Highly weathered, brownish grey, indistinctly foliated, fine grains are moderately compact **Hornblende schist**.
Rock Properties: Moderately hard and moderately strong rock.
Completely weathered, decomposed and completely disintegrated, fine to medium grained Hornblende schist at 4.50-5.25m, 7.50-9.00m, 11.25-18.00m depth.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly 3-sets of fractures. Open fracture surfaces are non-planar, rough and altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.

The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

IBH : 44

(00.00 – 03.50)m: Overburden.

(03.50 – 08.00)m: Completely weathered, decomposed and disintegrated, coarse grained Granite schist.

(08.00 – 20.00)m: **Rock Description**: Highly to moderately weathered, brownish grey, indistinctly foliated, coarse grains are tightly compact **Granite schist**.
Rock Properties: Hard and strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly 3-sets of fractures. Open fracture surfaces are non-planar, rough and highly altered.
Description of Core: Recovered core occurs as discontinuous (up to 10.25m) to continuous framework. Cores are mostly in lengths of 30-100mm mixed with rare 100-200mm pieces at places..
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly to moderately weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

IBH : 61

(00.00 – 09.50)m: Overburden.

(09.50 – 20.00)m: **(09.50-15.00)m:**
Rock Description: Highly weathered, light grey, very fine grains are loosely compact, laminated **Shale**.
Rock Properties: Soft and weak rock.
(15.00-20.00)m:
Rock Description: Highly weathered, yellowish grey with brown shades, bedded, fine grains are loosely compact **Sandstone**.
Rock Properties: Medium soft and weak rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fractures. Open fracture surfaces are planar, smooth and altered.
Description of Core: Recovered core occurs as discontinuous (up to 13.00m) to continuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

IBH : 62

(00.00 – 06.00)m: Overburden.

(06.00 – 20.00)m: **(06.00-15.75)m:**

Rock Description: Highly weathered and yellowish grey (up to 11.50m) to moderately weathered and, very fine grains are loosely compact, laminated **Shale**.

Rock Properties: Soft and weak rock.

(15.75-20.00)m:

Rock Description: Slightly weathered, light grey to yellowish grey, bedded, fine grains are moderate to tightly compact **Sandstone**.

Rock Properties: Medium soft and weak to moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m up to 12.75m) to medium spaced (8-5 nos/m) fractures. Dominantly horizontal fractures, with locally inclined (50° at 8.25-9.00m, 55° at 9.00-9.75m) fractures present. Open fracture surfaces are planar, smooth and altered (up to 13.00m) to fresh.

Description of Core: Recovered core occurs as discontinuous (up to 12.75m) to continuous framework. Cores are mostly in lengths of 30-100mm upto 12.75m. Thereafter cores are mostly of 100-200mm in size.

Rock Mass Structure: The rock mass is very poor (up to 12.75m) to fair.

Partial drill water loss has been noticed for the entire depth.

The formation rock is highly to slightly weathered and huge to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to little amount of core loss occurred.

IBH : 63

(00.00 – 04.60)m: Overburden.

(04.60 – 10.00)m: Alternative layers of sandstone and shale.

Rock Description: Highly weathered, yellowish grey to dark grey, bedded, fine to very fine grains are loosely compact alternation of **Sandstone-shale**.

(06.50-08.00)m, (14.00-15.00)m : Sandstone

(08.00-14.00)m : Shale

Rock Properties: Medium soft to soft and weak rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fractures, few Inclined (43° at 09.50m, 68° at 10.25m) fractures at also present. Open fracture surfaces are planar, smooth and altered.

Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of 30-100mm.

Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.

The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles

between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

IBH : 65

(00.00 – 04.00)m: Overburden.

(04.00 – 08.50)m: Completely weathered, decomposed and disintegrated, fine to medium grained Hornblende schist.

(08.50 – 20.00)m: **Rock Description**: Highly weathered, yellowish grey (up to 16.00m) to greenish grey, indistinctly foliated, fine grains are moderately (up to 16.50m) to tightly compact **Hornblende schist**.
Rock Properties: Moderately hard and moderately strong (up to 16.50m) to hard and strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fractures. Open fracture surfaces are non-planar, rough and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm mixed with 100-200mm pieces at places.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

IBH : 66

(00.00 – 05.00)m: Overburden.

(04.00 – 11.75)m: Completely weathered, decomposed and disintegrated, fine to medium grained Hornblende schist.

(11.75 – 20.00)m: **Rock Description**: Highly weathered, yellowish brown, indistinctly foliated, fine grains are moderately compact **Hornblende schist**.
Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly 3-sets of fractures. Open fracture surfaces are non-planar, rough and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

IBH : 67

(00.00 – 01.60)m: Overburden.

(01.60 – 20.00)m: **Rock Description**: Highly weathered, brownish grey, indistinctly foliated, fine grains are moderately compact **Hornblende schist**.

Rock Properties: Moderately hard and weak rock.
Completely weathered, decomposed and disintegrated, fine to medium grained Hornblende schist at 3.00-6.00m, 8.25-10.50m depth.

Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly 3-sets of fractures. Open fracture surfaces are non-planar, rough and altered.
Description of Core: Recovered core occurs as discontinuous framework. Cores are mostly in lengths of <30mm and 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly to completely weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

IBH : 73

(00.00 – 03.40)m: Overburden.

(03.40 – 30.00)m: **Rock Description**: Highly (up to 16.75m) to moderately (16.75-22.00m), followed by slightly weathered, light grey with dark patch/bands, foliated (55°), medium grains are densely compact **Granite gneiss**.
Rock Properties: Hard and strong rock.
Completely weathered, decomposed and disintegrated, fine to medium grained Granite gneiss at 06.25-13.00m depth.

Structural Condition: Very closely (up to 14.50m, >15 nos./m) then medium (8-5 nos/m) spaced fractures. Dominantly horizontal fractures. Open fracture surfaces are non-planar, rough and altered (up to 22.00m) to fresh.
Description of Core: Recovered core occurs as discontinuous (up to 16.75m) to continuous framework. Cores are mostly in lengths of 30-100mm up to 22.00m, followed by mostly 100-200mm pieces.
Rock Mass Structure: The rock mass is very poor to poor (up to 22.00m), followed by fair.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly to moderately weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

Project : Geotechnical Investigation at 3x800 MW PVUNL Patratu STPP, Jharkhand. CETEST

Job No : 4099 | Created by : Chandrani | Created on : 06/04/2018 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.142

Co-ordinates E=582.000 N=1513.000

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	10	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	10
		Disturbed (DS)	8
Vane (V)		Water Sample (WS)	0

Commencement Date : 02/04/2018
Completion Date : 04/04/2018
Bore Hole Diameter : 150 mm. / N.X.
Level Of Ground : 379.198 M.
Water Struck At :
Standing Water Level : 0.90 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15CM.	SAMPLES Ref. No	Depth (m)
0.00m.				
Medium dense, brownish grey, clayey silty silt / silty sand. Obs. kankars & boulder.		3 5 6 (11)	DS-1	0.50
			SPT-1	1.00-1.45
		NX rotary drilling from 3.00m to 20.00m	*UDS-1	2.00-2.14
2.50m.		>100		
Very dense, greyish brown, clayey silty sand with decomposed rock.		29 61 10.0 cm Pentn.	SPT-2	2.50-2.75
3.00m.		100 Refusal	*SPT-3	3.00-3.05 3.00
Completely weathered, deep grey, fine grained, decomposed hornblende schist.		5.0 cm Pentn. Refusal	R1	CR=NIL RQD=NIL
		100	DS-2 *SPT-4	3.75-3.79 3.75
		4.0 cm Pentn. Refusal	R2	CR=NIL RQD=NIL
		100	DS-3 *SPT-5	4.50-4.53 4.50
		3.0 cm Pentn. Refusal	R3	CR=NIL RQD=NIL
		100	DS-4 *SPT-6	5.25-5.27 5.25
		2.0 cm Pentn. Refusal	R4	CR=NIL RQD=NIL
		100	DS-5 *SPT-7	6.00-6.03 6.00
		3.0 cm Pentn. Refusal	R5	CR=NIL RQD=NIL
		100	DS-6 *SPT-8	6.75-6.79 6.75
		4.0 cm Pentn. Refusal	R6	CR=NIL RQD=NIL
		100	DS-7 *SPT-9	7.50-7.53 7.50
		3.0 cm Pentn. Refusal	R7	CR=NIL RQD=NIL
8.25m.		100	DS-8 *SPT-10	8.25-8.29 8.25
		4.0 cm Pentn.	R8	CR=20% RQD=NIL
				9.00
Highly weathered, dark grey to yellowish brown, medium to fine grained, highly fractured hornblende schist.			R9	CR=21% RQD=NIL
				9.75
			R10	CR=22% RQD=NIL
10.50m.				10.50

Project : Geotechnical Investigation at 3x800 MW PVUNL Patratu STPP, Jharkhand.			CETEST
Job No : 4099	Created by : Chandrani	Created on : 06/04/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.142

Co-ordinates E=582.000 N=1513.000

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	10	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	10
Vane (V)		Disturbed (DS)	8
		Water Sample (WS)	0

Commencement Date : 02/04/2018
Completion Date : 04/04/2018
Bore Hole Diameter : 150 mm. / N.X.
Level Of Ground : 379.198 M.
Water Struck At :
Standing Water Level : 0.90 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15CM.	SAMPLES Ref. No	SAMPLES Depth (m)
10.50m.				
			R11	CR=21% RQD=NIL
				11.25
			R12	CR=23% RQD=NIL
				12.00
			R13	CR=24% RQD=NIL
				12.75
			R14	CR=22% RQD=NIL
				13.50
			R15	CR=21% RQD=NIL
				14.25
			R16	CR=26% RQD=NIL
Highly weathered, dark grey to yellowish brown, medium to fine grained, highly fractured hornblende schist.				15.00
			R17	CR=27% RQD=NIL
				15.75
			R18	CR=24% RQD=NIL
				16.50
			R19	CR=22% RQD=NIL
				17.25
			R20	CR=25% RQD=NIL
				18.00
			R21	CR=26% RQD=NIL
				18.75
			R22	CR=22% RQD=NIL
				19.50
			R23	CR=24% RQD=NIL
20.00m.				20.00

N.B. – '*' means sample could not be recovered.

Project : Geotechnical Investigation at 3x800 MW PVUNL Patratu STPP, Jharkhand. CETEST

Job No : 4099 | Created by : Chandrani | Created on : 09/04/2018 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.143

Co-ordinates E=589 N=1478

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	9	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	9
Vane (V)		Disturbed (DS)	7
		Water Sample (WS)	1

Commencement Date : 04/04/2018
Completion Date : 05/04/2018
Bore Hole Diameter : 150 mm. / N.X.
Level Of Ground : 378.530 M.
Water Struck At :
Standing Water Level : 0.70 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15CM.	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Loose, brownish grey, clayey silt with sand mixture / clayey silty sand.		2 3 5 — 8	DS-1 WS-1 SPT-1	0.50 0.70 1.00-1.45
1.90m.				
Very dense, yellowish grey, silty sand with decomposed rock pieces.		100 11.0 cm Pentn. — >100 Refusal	*UDS-1 SPT-2	2.00-2.10 2.25-2.36
2.50m.		100 5.0 cm Pentn. — Refusal	*SPT-3 R1 DS-2	2.50-2.55 2.50 CR=NIL RQD=NIL
Completely weatherd, greyish brown, medium grained, decomposd hornblende schist.		100 3.0 cm Pentn. — Refusal	*SPT-4 R2 DS-3	3.25-3.28 3.25 CR=NIL RQD=NIL
		100 4.0 cm Pentn. — Refusal	*SPT-5 R3 DS-4	4.00-4.04 4.00 CR=NIL RQD=NIL
		100 2.0 cm Pentn. — Refusal	*SPT-6 R4 DS-5	4.75-4.77 4.75 CR=NIL RQD=NIL
		100 3.0 cm Pentn. — Refusal	*SPT-7 R5 DS-6	5.50-5.53 5.50 CR=NIL RQD=NIL
		100 3.0 cm Pentn. — Refusal	*SPT-8 R6 DS-7	6.25-6.28 6.25 CR=NIL RQD=NIL
7.00m.		100 4.0 cm Pentn.	*SPT-9	7.00-7.04 7.00
		NX rotary drilling from 2.50m to 15.00m	R7	CR=20% RQD=NIL 7.75
			R8	CR=22% RQD=NIL 8.50
			R9	CR=24% RQD=NIL 9.25
			R10	CR=23% RQD=NIL 10.00
			R11	CR=21% RQD=NIL 10.75
Highly weathered, yellowish brown, fine to medium grained, highly fractured hornblende schist.			R12	CR=20% RQD=NIL 11.50
			R13	CR=23% RQD=NIL 12.25
			R14	CR=25% RQD=NIL 13.00
			R15	CR=22% RQD=NIL 13.75
			R16	CR=24% RQD=NIL 14.50
15.00m.			R17	CR=26% RQD=NIL 15.00

N.B. – '*' means sample could not be recovered.

Project : Geotechnical Investigation at 3x800 MW PVUNL Patratu STPP, Jharkhand. CETEST

Job No : 4099 | Created by : Chandrani | Created on : 04/04/2018 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.144

Co-ordinates E=580 N=1428

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	15	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	15
Vane (V)		Disturbed (DS)	4
		Water Sample (WS)	1

Commencement Date : 01/04/2018
Completion Date : 02/04/2018
Bore Hole Diameter : 150 mm. / N.X.
Level Of Ground : 378.798 M.
Water Struck At :
Standing Water Level : 1.90 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15CM.	SAMPLES Ref. No	Depth (m)
0.00m. Medium dense, greyish yellow, sandy silt / clayey silty sand.		5 7 8 (15)	DS-1	0.50
			SPT-1	1.00-1.45
			UDS-1	2.00-2.45
2.50m. Very dense, greenish grey, silty sand with decomposed rock & kankars.		47 (100) 3.0 cm Pentn. (>100)	SPT-2	2.80-2.98
3.30m.		100 5.0 cm Pentn. Refusal	*SPT-3	3.30-3.35 3.30
			R1	CR=NIL RQD=NIL
			DS-2	
Completely weathered, greenish grey, medium to fine grained, decomposed hornblende schist.		100 4.0 cm Pentn. Refusal	*SPT-4	4.00-4.04 4.00
			R2	CR=NIL RQD=NIL
		100 3.0 cm Pentn. Refusal	DS-3 *SPT-5	4.75-4.78 4.75
			R3	CR=NIL RQD=NIL
5.50m.		100 3.0 cm Pentn. Refusal	DS-4 *SPT-6	5.50-5.53 5.50
			R4	CR=15% RQD=NIL
		100 4.0 cm Pentn. Refusal	*SPT-7	6.25-6.29 6.25
			R5	CR=12% RQD=NIL
Completely weathered, greenish grey, medium to fine grained, highly fractured hornblende schist.		100 3.0 cm Pentn. Refusal	*SPT-8	7.00-7.03 7.00
			R6	CR=14% RQD=NIL
		100 3.0 cm Pentn.	*SPT-9	7.75-7.78 7.75
			R7	CR=20% RQD=NIL
		NX rotary drilling from 3.30m to 15.00m		8.50
			R8	CR=18% RQD=NIL
9.25m.		Refusal	*SPT-10	9.25-9.29 9.25
		100 4.0 cm Pentn. Refusal	R9	CR=15% RQD=NIL
		100 2.0 cm Pentn. Refusal	*SPT-11	10.00-10.02 10.00
			R10	CR=13% RQD=NIL
		100 3.0 cm Pentn. Refusal	*SPT-12	10.75-10.78 10.75
			R11	CR=19% RQD=NIL
		100 4.0 cm Pentn. Refusal	*SPT-13	11.50-11.54 11.50
Completely to highly weathered, yellowish grey to yellowish brown, fine to medium grained, highly fractured hornblende schist.			R12	CR=16% RQD=NIL
		100 3.0 cm Pentn.	*SPT-14	12.25-12.28 12.25
			R13	CR=20% RQD=NIL
				13.00
		Refusal	R14	CR=18% RQD=NIL
		100 3.0 cm Pentn.	*SPT-15	13.75-13.78 13.75
			R15	CR=21% RQD=NIL
				14.50
			R16	CR=24% RQD=NIL
15.00m.				15.00

N.B. - '*' means sample could not be recovered.

Project : Geotechnical Investigation at 3x800 MW PVUNL Patratu STPP, Jharkhand. CETEST

Job No : 4099 | Created by : Chandrani | Created on : 09/04/2018 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.150

Co-ordinates E=512 N=1445

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	14	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	14
Vane (V)		Disturbed (DS)	12
		Water Sample (WS)	0

Commencement Date : 03/04/2018
Completion Date : 05/04/2018
Bore Hole Diameter : 150 mm. / N.X.
Level Of Ground : 380.687 M.
Water Struck At :
Standing Water Level : 2.20 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15CM.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Very stiff, brownish grey, silty clay. Obs. kankars & grey patches.		6 9 9 — 18	DS-1	0.50
			SPT-1	1.00-1.45
		NX rotary drilling from 3.20m to 20.00m	UDS-1	2.00-2.45
2.50m.				
Very dense, deep grey, silty sand with decomposed rock pieces.		32 68 / 10.0 cm Pentn. — >100	SPT-2	2.75-3.00
3.20m.		100 / 5.0 cm Pentn. — Refusal	*SPT-3	3.20-3.25
			R1	CR=NIL RQD=NIL
		100 / 4.0 cm Pentn. — Refusal	DS-2 *SPT-4	4.00-4.04
			R2	CR=20% RQD=NIL
			R3	CR=21% RQD=NIL
Completely to highly weathered, greenish grey to pinkish grey, medium to fine grained, fractured hornblende gniess.			R4	CR=NIL RQD=NIL
		100 / 2.0 cm Pentn. — Refusal	DS-3 *SPT-5	6.25-6.27
			R5	CR=23% RQD=NIL
			R6	CR=25% RQD=NIL
			R7	CR=20% RQD=NIL
8.50m.			R8	CR=NIL RQD=NIL
Completely weathered, greyish brown, fine to medium grained, decomposed hornblende gniess.		100 / 3.0 cm Pentn. — Refusal	DS-4 *SPT-6	9.25-9.28
			R9	CR=NIL RQD=NIL
		100 / 4.0 cm Pentn. — Refusal	DS-5 *SPT-7	10.00-10.04
10.50m.			R10	CR=NIL RQD=NIL

3.20 / 4.00 / 4.75 / 5.50 / 6.25 / 7.00 / 7.75 / 8.50 / 9.25 / 10.00

Project : Geotechnical Investigation at 3x800 MW PVUNL Patratu STPP, Jharkhand. CETEST

Job No : 4099 | Created by : Chandrani | Created on : 09/04/2018 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.150

Co-ordinates E=512 N=1445

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	14	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	14
Vane (V)		Disturbed (DS)	12
		Water Sample (WS)	0

Commencement Date : 03/04/2018
Completion Date : 05/04/2018
Bore Hole Diameter : 150 mm. / N.X.
Level Of Ground : 380.687 M.
Water Struck At :
Standing Water Level : 2.20 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15CM.	SAMPLES Ref. No	SAMPLES Depth (m)
10.50m.				
Completely weathered, greyish brown, fine to medium grained, decomposed hornblende gniess.		100 Refusal 2.0 cm Pentn.	DS-6 *SPT-8	10.75-10.77
			R11	CR=NIL RQD=NIL
		100 Refusal 3.0 cm Pentn.	DS-7 *SPT-9	11.50-11.53
			R12	CR=NIL RQD=NIL
12.25m.		100 Refusal 3.0 cm Pentn.	DS-8 *SPT-10	12.25-12.28
			R13	CR=22% RQD=NIL
			R14	CR=24% RQD=NIL
			R15	CR=26% RQD=NIL
			R16	CR=NIL RQD=NIL
		100 Refusal 4.0 cm Pentn.	DS-9 *SPT-11	15.25-15.29
			R17	CR=NIL RQD=NIL
Completely to highly weathered, greenish grey, medium grained to fine grained, highly fractured hornblende gniess.		100 Refusal 3.0 cm Pentn.	DS-10 *SPT-12	16.00-16.03
			R18	CR=NIL RQD=NIL
		100 Refusal 3.0 cm Pentn.	DS-11 *SPT-13	16.75-16.78
			R19	CR=NIL RQD=NIL
		100 Refusal 2.0 cm Pentn.	DS-12 *SPT-14	17.50-17.52
			R20	CR=20% RQD=NIL
			R21	CR=23% RQD=NIL
			R22	CR=21% RQD=NIL
20.00m.				

10.75 / 11.50 / 12.25 / 13.00 / 13.75 / 14.50 / 15.25 / 16.00 / 16.75 / 17.50 / 18.25 / 19.00 / 20.00

N.B. – '*' means sample could not be recovered.

ELECTRICAL RESISTIVITY TEST

REPORT ON
ELECTRICAL RESISTIVITY TEST (ERT) FOR
3 x 800 MW PVUNL PATRATU STPP
AT RAMGARH, JHARKHAND

INTRODUCTION:

Electrical Resistivity Test was carried out for 3 x 800 MW PVUNL Patratu STPP at Ramgarh, Jharkhand from 04.03.2018 to 13.03.2018 & 25.04.218 to 27.04.2018 at fifty eight (58) locations around plant area as per IS 3043 : 1987.

METHODOLOGY:

The Soil Resistivity Survey is a method to find out the Electrical Resistivity (Specific Resistance) of a medium. It is the resistance offered by a unit cube of a particular medium (so called strata below the ground level) when a unit current passes perpendicular to the surface of a cross-sectional area A. The relation is given by Ohm's Law is –

$$\rho = R \text{ ohm} \frac{A}{l} = \text{ohm} \frac{m^2}{m} = \text{ohm} - m$$ where

ρ= Resistivity, R = resistance offered by the medium of length L and Cross-sectional area A.

In electrical resistivity survey a known current I (direct current or low frequency alternating current) is sent into the ground through a pair of current electrodes A & B and the potential difference (ΔV) created in the medium is measured between another pair of electrodes M & N. The resistivity of the formation is then given

by $\rho = K \frac{\Delta V}{I}$ where ρ is the apparent resistivity, K is the geometric factor.

In the Earth Resistivity Test, the Wenner configuration was followed. In this configuration two potential electrodes M & N are placed in a line with the current electrodes A & B, all four being situated equidistance from one to another and disposed symmetrically with respect to

a central point such that AM=MN=NB=a . The outer two electrodes A & B were used for sending current (I) and inner two M & N were used for measuring the potential differences (ΔV). The distance between each consecutive electrode (a) was kept constant and was progressively increased to reach the depth at which resistivity information are wanted. Suitable electrode spacing determines the conductivity of the top soil as well as the various subsurface layers occurring in the area under study. At each location, 4 sets of observations were taken for each of the electrode spacing (a) in eight directions (N-S,E-W,NE-SW and NW-SE) and in ten different electrode spacing viz,: a = 0.50m, 1.0m, 2.0m, 3.0m, 4.0m, 5.0m, 6.0m, 7.0m, 8.0m and 10.0m were used to know the nature of change of resistivity.

The apparent resistivity was determined by the formula –

$\rho = 6.28\, a \frac{\Delta V}{I}$ where 'a' is the distance between the two consecutive Electrodes and $\frac{\Delta V}{I}$ is R which is the observed resistance for measuring resistivity.

A Resistivity Meter model DDR-3 of GEOSENSOR make was used during the operation. The mean value of the resistivity estimated was taken as the representative one.

The depth of investigation in an isotropic and homogeneous formation can be approximated to the distance between the consecutive two electrodes (a).

TEST RESULTS:

The overall mean resistivity values at each ERT locations are presented below

APPARENT RESISTIVITY VALUES

Sl. No.	ERT Location	Co-ordinate (M)		Overall Mean Resistivity (Ohm-m)
		Easting	Northing	
1.	ERT -01	1867	1298	166.52
2.	ERT -02	1787	1369	193.12
3.	ERT -03	1907	1369	196.88
4.	ERT -04	1827	1437	272.69
5.	ERT -05	1787	1505	30.51
6.	ERT -06	1907	1505	74.80
7.	ERT -07	1867	1573	21.04
8.	ERT - 08	1593	1578	184.64
9.	ERT -09	1593	1448	135.23
10.	ERT -10	1593	1318	126.87

Sl. No.	ERT Location	Co-ordinate (M)		Overall Mean Resistivity (Ohm-m)
		Easting	Northing	
11.	ERT -11	1541	1242	112.10
12.	ERT -12	1516	1293	166.88
13.	ERT -13	1543	1383	242.25
14.	ERT -14	1543	1513	118.71
15.	ERT -15	1543	1643	103.09
16.	ERT -16	1448	1620	167.55
17.	ERT -17	1448	1549	127.76
18.	ERT -18	1448	1495	374.16
19.	ERT -19	1448	1407	225.86
20.	ERT -20	1448	1289	111.36
21.	ERT -21	1413	1242	85.91
22.	ERT -22	1382	1301	137.84
23.	ERT -23	1302	1313	101.31
24.	ERT -24	1302	1456	85.09
25.	ERT -25	1382	1443	151.11
26.	ERT -26	1302	1637	269.71
27.	ERT -27	1382	1656	86.21
28.	ERT -28	1222	1656	24.51
29.	ERT -29	1222	1514	33.81
30.	ERT -30	1262	1372	47.82
31.	ERT -31	1182	1265	29.02
32.	ERT -32	1059	1308	17.49
33.	ERT -33	1116	1377	52.38
34.	ERT -34	1059	1454	20.38
35.	ERT -35	1113	1541	42.51
36.	ERT -36	1059	1611	42.11
37.	ERT -37	1082	1662	36.47
38.	ERT -38	988	1570	14.85
39.	ERT -39	968	1392	14.04
40.	ERT -40	981	1296	31.04
41.	ERT -41	848	1656	62.09
42.	ERT -42	848	1510	63.55
43.	ERT -43	815	1408	20.75
44.	ERT -44	703	1445	32.03
45.	ERT -45	640	1505	26.35
46.	ERT -46	543	1438	28.38
47.	ERT -47	644	1384	178.18
48.	ERT -48	507	1298	33.12
49.	ERT -49	311	1272	102.57
50.	ERT -50	541	850	86.37
51.	ERT -51	1849	1540	61.72
52.	ERT -52	1867	1476	160.42
53.	ERT -53	1867	1400	116.03
54.	ERT -54	1827	1333	145.58
55.	ERT -55	1502	1560	206.50
56.	ERT -56	1502	1461	129.21
57.	ERT -57	1502	1351	263.06
58.	ERT -58	800	1643	46.62

ERT No. 01

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	283.54	235.19	320.28	287.31	281.58
2	1.0	235.88	237.76	252.23	245.31	242.80
3	2.0	206.15	198.61	256.43	228.77	222.49
4	3.0	167.85	160.31	211.23	162.20	175.40
5	4.0	145.81	118.16	206.15	143.30	153.36
6	5.0	116.29	110.01	172.87	147.72	136.72
7	6.0	90.50	105.59	147.07	147.07	122.56
8	7.0	96.80	101.20	140.80	110.00	112.20
9	8.0	95.55	90.52	140.81	105.61	108.12
10	10.0	106.86	100.58	119.43	113.15	110.01

Mean Resistivity at ERT-01 is 166.52 Ohm - m.

ERT No. 02

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	132.19	123.72	135.33	126.86	129.53
2	1.0	140.90	167.31	126.43	142.15	144.20
3	2.0	173.47	173.47	159.64	154.61	165.30
4	3.0	192.37	165.67	194.26	167.85	180.04
5	4.0	216.20	178.49	183.52	163.41	185.41
6	5.0	223.15	176.01	226.30	188.58	203.51
7	6.0	245.12	192.32	252.66	196.09	221.55
8	7.0	250.80	189.20	272.80	206.80	229.90
9	8.0	266.54	201.16	271.57	211.22	237.62
10	10.0	257.73	194.87	270.30	213.72	234.16

Mean Resistivity at ERT-02 is 193.12 Ohm - m.

ERT No. 03

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	581.84	554.52	540.08	527.52	550.99
2	1.0	339.66	349.72	327.08	334.63	337.77
3	2.0	207.41	175.98	213.69	226.26	205.84
4	3.0	173.51	158.42	177.28	186.71	173.98
5	4.0	145.81	125.70	133.24	138.27	135.76
6	5.0	157.15	119.43	154.01	150.86	145.36
7	6.0	105.59	105.59	116.90	131.99	115.02
8	7.0	110.00	92.40	127.60	123.20	113.30
9	8.0	90.52	85.49	105.61	110.64	98.07
10	10.0	88.00	75.43	100.58	106.86	92.72

Mean Resistivity at ERT-03 is 196.88 Ohm - m.

ERT No. 04

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	159.83	129.37	163.59	156.37	152.29
2	1.0	149.70	145.93	141.53	138.38	143.89
3	2.0	208.66	194.84	202.38	268.66	218.64
4	3.0	262.15	260.27	254.61	258.38	258.85
5	4.0	294.14	294.14	258.94	263.97	277.80
6	5.0	289.16	298.59	295.44	311.16	298.59
7	6.0	320.54	335.62	320.54	335.62	328.08
8	7.0	325.60	338.80	347.60	360.80	343.20
9	8.0	341.97	357.06	336.94	347.00	345.74
10	10.0	352.02	364.59	358.30	364.59	359.88

Mean Resistivity at ERT-04 is 272.69 Ohm - m.

ERT No. 05

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	17.84	20.13	21.07	22.64	20.42
2	1.0	22.33	22.08	23.65	23.34	22.85
3	2.0	24.26	24.64	25.27	25.77	24.99
4	3.0	23.01	26.78	24.71	29.80	26.08
5	4.0	24.89	25.39	25.89	26.90	25.77
6	5.0	29.23	30.17	30.17	31.12	30.17
7	6.0	30.55	32.43	32.05	33.56	32.15
8	7.0	34.76	36.52	36.08	37.40	36.19
9	8.0	36.21	39.73	37.72	40.73	38.60
10	10.0	46.52	48.40	47.77	49.03	47.93

Mean Resistivity at ERT-05 is 30.51 Ohm - m.

ERT No. 06

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	30.17	31.46	32.03	34.13	31.95
2	1.0	36.61	39.50	39.94	39.56	38.90
3	2.0	67.75	75.17	68.13	75.92	71.74
4	3.0	79.78	82.61	79.21	83.92	81.38
5	4.0	76.43	81.70	78.44	79.95	79.13
6	5.0	80.78	68.83	82.35	82.66	78.66
7	6.0	89.00	78.44	90.50	85.22	85.79
8	7.0	84.92	87.56	86.68	97.68	89.21
9	8.0	94.55	88.01	93.54	87.00	90.78
10	10.0	104.35	97.43	99.95	99.95	100.42

Mean Resistivity at ERT-06 is 74.80 Ohm - m.

ERT No. 07

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	14.66	14.19	13.19	12.91	13.74
2	1.0	16.04	16.67	13.65	13.33	14.92
3	2.0	28.41	26.65	12.70	12.44	20.05
4	3.0	18.81	24.52	16.03	12.45	17.95
5	4.0	18.60	22.37	18.60	12.57	18.04
6	5.0	19.49	27.34	19.49	15.09	20.35
7	6.0	20.37	31.30	22.25	16.22	22.53
8	7.0	22.88	35.64	24.64	17.16	25.08
9	8.0	24.64	39.73	26.15	18.61	27.28
10	10.0	27.60	41.49	30.80	22.00	30.47

Mean Resistivity at ERT-07 is 21.04 Ohm - m.

ERT No. 08

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	396.58	379.94	392.50	343.83	378.21
2	1.0	323.31	276.76	144.67	278.02	255.69
3	2.0	211.18	191.06	172.21	275.28	212.43
4	3.0	150.88	184.83	230.09	275.36	210.29
5	4.0	113.13	128.21	128.21	246.37	153.98
6	5.0	106.86	141.44	138.29	257.73	161.08
7	6.0	94.28	120.67	109.36	199.86	131.04
8	7.0	101.20	114.40	96.80	176.00	122.10
9	8.0	100.58	110.64	105.61	110.64	106.87
10	10.0	113.15	119.43	113.15	113.15	114.72

Mean Resistivity at ERT-08 is 184.64 Ohm - m.

ERT No. 09

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	243.66	180.55	244.92	169.25	209.60
2	1.0	142.15	172.98	147.19	96.24	139.64
3	2.0	131.99	126.96	140.78	129.47	132.30
4	3.0	141.45	164.08	148.99	111.27	141.45
5	4.0	130.73	115.64	138.27	105.59	122.56
6	5.0	144.58	97.43	147.72	122.58	128.08
7	6.0	105.59	109.34	109.36	120.67	111.24
8	7.0	114.40	118.80	110.00	123.20	116.60
9	8.0	120.70	115.67	115.67	135.78	121.96
10	10.0	125.72	119.43	119.43	150.86	128.86

Mean Resistivity at ERT-09 is 135.23 Ohm - m.

ERT No. 10

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	250.26	241.78	245.23	243.35	245.16
2	1.0	122.66	161.65	128.95	154.73	142.00
3	2.0	105.59	188.55	126.96	165.92	146.76
4	3.0	96.19	124.48	118.82	130.13	117.41
5	4.0	105.59	115.64	120.67	133.24	118.79
6	5.0	91.15	88.00	103.72	116.29	99.79
7	6.0	94.28	101.82	101.82	113.13	102.76
8	7.0	92.40	105.60	101.20	114.40	103.40
9	8.0	95.55	105.61	100.58	110.64	103.10
10	10.0	75.43	88.00	94.29	100.58	89.58

Mean Resistivity at ERT-10 is 126.87 Ohm - m.

ERT No. 11

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	194.68	179.92	273.18	248.37	224.04
2	1.0	176.12	130.20	184.93	127.69	154.74
3	2.0	172.21	164.67	118.16	113.13	142.04
4	3.0	90.53	101.84	115.05	122.59	107.50
5	4.0	82.96	87.99	82.96	87.99	85.48
6	5.0	75.43	91.15	97.43	110.01	93.51
7	6.0	56.57	71.65	79.19	90.50	74.48
8	7.0	70.40	83.60	88.00	101.20	85.80
9	8.0	70.41	85.49	85.49	95.55	84.24
10	10.0	56.57	62.86	75.43	81.72	69.15

Mean Resistivity at ERT-11 is 112.10 Ohm - m.

ERT No. 12

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	268.78	246.18	279.15	250.26	261.09
2	1.0	252.23	194.36	240.28	192.47	219.84
3	2.0	211.18	207.41	227.52	219.98	216.52
4	3.0	154.65	164.08	169.74	175.40	165.97
5	4.0	135.76	170.95	158.38	173.47	159.64
6	5.0	144.58	138.29	169.72	179.15	157.94
7	6.0	124.44	143.30	150.84	169.70	147.07
8	7.0	132.00	149.60	154.00	171.60	151.80
9	8.0	80.46	95.55	105.61	115.67	99.32
10	10.0	75.43	88.00	94.29	100.58	89.58

Mean Resistivity at ERT-12 is 166.88 Ohm - m.

ERT No. 13

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	227.65	197.51	197.51	208.18	207.71
2	1.0	187.44	147.19	188.07	153.48	169.05
3	2.0	187.29	192.32	207.41	187.29	193.58
4	3.0	220.66	260.27	177.28	245.18	225.85
5	4.0	221.23	248.89	203.63	251.40	231.29
6	5.0	248.30	254.58	238.87	235.73	244.37
7	6.0	230.03	282.83	218.72	275.28	251.72
8	7.0	255.20	303.60	250.80	308.00	279.40
9	8.0	241.39	311.80	271.57	326.89	287.91
10	10.0	264.01	370.87	314.30	377.16	331.59

Mean Resistivity at ERT-13 is 242.25 Ohm - m.

ERT No. 14

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	167.68	168.93	163.28	155.74	163.91
2	1.0	71.70	88.06	89.32	96.24	86.33
3	2.0	86.73	100.56	93.02	90.50	92.70
4	3.0	99.96	133.91	126.36	86.76	111.75
5	4.0	87.99	125.71	153.35	98.05	116.28
6	5.0	94.29	128.86	185.44	106.86	128.86
7	6.0	105.59	113.13	196.09	113.13	131.99
8	7.0	110.00	118.80	158.40	118.80	126.50
9	8.0	105.61	120.70	120.70	115.67	115.67
10	10.0	106.86	106.86	125.72	113.15	113.15

Mean Resistivity at ERT-14 is 118.71 Ohm - m.

ERT No. 15

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	117.75	108.02	94.83	104.31	106.23
2	1.0	108.94	113.97	131.59	108.82	115.83
3	2.0	96.79	85.98	80.45	84.72	86.99
4	3.0	68.65	82.61	100.34	87.89	84.87
5	4.0	75.42	88.49	93.02	81.96	84.72
6	5.0	81.72	109.38	86.75	85.49	90.84
7	6.0	91.26	105.59	83.72	95.78	94.09
8	7.0	87.12	167.20	89.76	98.56	110.66
9	8.0	96.56	188.08	95.55	93.54	118.43
10	10.0	99.32	250.18	103.09	100.58	138.29

Mean Resistivity at ERT-15 is 103.09 Ohm - m.

ERT No. 16

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	378.06	266.90	286.37	377.11	327.11
2	1.0	178.64	144.04	176.12	171.09	167.47
3	2.0	110.62	105.59	105.59	116.90	109.68
4	3.0	145.22	141.45	103.73	135.79	131.55
5	4.0	123.19	140.78	90.50	85.48	109.99
6	5.0	147.72	169.72	94.29	88.00	124.93
7	6.0	154.61	188.55	101.82	120.67	141.41
8	7.0	184.80	211.20	154.00	184.80	183.70
9	8.0	170.99	231.33	201.16	186.07	197.39
10	10.0	201.15	201.15	176.01	150.86	182.29

Mean Resistivity at ERT-16 is 167.55 Ohm - m.

ERT No. 17

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	513.39	477.28	446.51	521.87	489.76
2	1.0	147.19	139.64	157.25	183.67	156.94
3	2.0	64.11	66.62	66.62	72.91	67.57
4	3.0	66.01	62.24	92.41	71.67	73.08
5	4.0	67.88	80.45	70.39	65.36	71.02
6	5.0	81.72	88.00	81.72	75.43	81.72
7	6.0	71.65	94.28	79.19	79.19	81.08
8	7.0	52.80	92.40	83.60	88.00	79.20
9	8.0	55.32	95.55	85.49	95.55	82.98
10	10.0	62.86	106.86	100.58	106.86	94.29

Mean Resistivity at ERT-17 is 127.76 Ohm - m.

ERT No. 18

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	265.96	257.48	279.46	276.63	269.88
2	1.0	330.23	322.05	364.82	275.50	323.15
3	2.0	407.27	314.25	407.27	395.96	381.19
4	3.0	430.01	407.38	462.07	424.35	430.95
5	4.0	269.00	487.72	462.58	414.81	408.53
6	5.0	311.16	345.73	477.74	455.74	397.59
7	6.0	339.33	320.59	520.40	316.76	374.27
8	7.0	382.80	378.40	528.00	303.60	398.20
9	8.0	397.29	402.32	387.23	266.54	363.35
10	10.0	440.02	484.02	333.16	320.59	394.45

Mean Resistivity at ERT-18 is 374.16 Ohm - m.

ERT No. 19

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	339.12	320.28	488.27	395.33	385.75
2	1.0	269.21	325.19	228.96	252.23	268.90
3	2.0	356.99	365.79	142.04	279.05	285.97
4	3.0	311.19	358.34	186.71	194.26	262.63
5	4.0	158.38	248.89	143.30	231.29	195.47
6	5.0	176.01	260.87	160.29	260.87	214.51
7	6.0	158.38	131.99	158.38	263.97	178.18
8	7.0	132.00	123.20	149.60	250.81	163.90
9	8.0	145.84	105.61	145.84	181.04	144.58
10	10.0	169.72	119.43	169.72	176.01	158.72

Mean Resistivity at ERT-19 is 225.86 Ohm - m.

ERT No. 20

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	124.66	152.60	134.71	159.83	142.95
2	1.0	123.28	122.03	134.61	132.09	128.00
3	2.0	129.47	130.73	144.56	147.07	137.96
4	3.0	90.53	116.93	103.73	126.36	109.39
5	4.0	82.96	110.62	98.05	115.64	101.82
6	5.0	97.43	75.43	110.01	94.29	94.29
7	6.0	101.82	82.96	116.90	101.82	100.88
8	7.0	105.60	88.00	118.80	101.20	103.40
9	8.0	100.58	85.49	115.67	100.58	100.58
10	10.0	94.29	81.72	106.86	94.29	94.29

Mean Resistivity at ERT-20 is 111.36 Ohm - m.

ERT No. 21

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	115.55	113.98	139.42	137.85	126.70
2	1.0	110.08	106.30	123.28	118.25	114.48
3	2.0	94.28	86.73	110.62	82.96	93.65
4	3.0	84.87	88.64	92.41	98.07	91.00
5	4.0	80.45	70.39	93.02	85.48	82.34
6	5.0	69.15	78.58	84.86	94.29	81.72
7	6.0	71.65	82.96	82.96	98.05	83.91
8	7.0	52.80	61.60	61.60	74.80	62.70
9	8.0	55.32	60.35	65.38	70.41	62.87
10	10.0	50.29	62.86	56.57	69.15	59.72

Mean Resistivity at ERT-21 is 85.91 Ohm - m.

ERT No. 22

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	168.93	163.28	175.84	162.97	167.76
2	1.0	147.19	144.04	168.57	138.38	149.55
3	2.0	124.44	118.16	118.16	121.93	120.67
4	3.0	115.05	118.82	132.02	154.65	130.14
5	4.0	105.59	115.64	153.35	193.58	142.04
6	5.0	122.58	116.29	147.72	194.87	145.37
7	6.0	109.36	120.67	147.07	184.78	140.47
8	7.0	114.40	140.81	118.80	167.20	135.30
9	8.0	105.61	125.73	115.67	125.73	118.19
10	10.0	119.43	132.01	125.72	138.29	128.86

Mean Resistivity at ERT-22 is 137.83 Ohm - m.

ERT No. 23

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	227.65	231.10	322.79	274.12	263.92
2	1.0	142.15	137.12	189.33	188.07	164.17
3	2.0	65.36	52.79	70.39	128.21	79.19
4	3.0	75.44	39.61	82.98	96.19	73.56
5	4.0	90.50	30.17	95.53	118.16	83.59
6	5.0	88.00	34.57	81.72	100.58	76.22
7	6.0	98.05	37.71	71.65	82.96	72.59
8	7.0	96.80	35.20	61.60	79.20	68.20
9	8.0	100.58	35.20	60.35	60.35	64.12
10	10.0	113.15	37.72	62.86	56.57	67.58

Mean Resistivity at ERT-23 is 101.31 Ohm - m.

ERT No. 24

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	174.58	138.16	167.99	163.91	161.16
2	1.0	155.99	177.38	150.96	172.98	164.33
3	2.0	95.53	82.96	99.30	89.25	91.76
4	3.0	92.41	60.35	82.92	79.21	78.72
5	4.0	95.53	50.28	72.91	67.88	71.65
6	5.0	81.72	47.15	69.15	50.29	62.08
7	6.0	52.79	49.82	64.11	41.48	52.05
8	7.0	48.40	61.60	61.60	44.00	53.90
9	8.0	45.26	62.38	60.35	60.35	57.09
10	10.0	44.00	69.15	62.86	56.57	58.15

Mean Resistivity at ERT-24 is 85.09 Ohm - m.

ERT No. 25

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	268.47	225.45	278.52	226.08	249.63
2	1.0	128.32	93.72	92.46	87.43	100.48
3	2.0	130.73	118.16	126.96	118.16	123.50
4	3.0	181.06	148.99	169.74	113.16	153.24
5	4.0	173.47	128.21	206.15	120.67	157.13
6	5.0	166.58	147.72	242.01	116.29	168.15
7	6.0	165.92	116.90	150.84	105.59	134.81
8	7.0	154.00	127.60	162.80	114.40	139.70
9	8.0	150.87	140.81	140.81	120.70	138.30
10	10.0	144.58	169.72	150.86	119.43	146.15

Mean Resistivity at ERT-25 is 151.11 Ohm - m.

ERT No. 26

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	276.95	449.02	32.07	219.49	244.38
2	1.0	247.20	332.74	300.03	240.28	280.06
3	2.0	172.21	360.76	307.97	419.84	315.20
4	3.0	228.21	418.69	294.22	414.92	339.01
5	4.0	248.89	299.17	314.25	289.11	287.86
6	5.0	248.30	286.01	298.59	264.01	274.23
7	6.0	233.80	230.03	279.05	188.55	232.86
8	7.0	246.40	228.80	299.20	202.40	244.20
9	8.0	170.99	311.80	271.57	201.16	238.88
10	10.0	182.29	333.16	251.44	194.87	240.44

Mean Resistivity at ERT-26 is 269.71 Ohm - m.

ERT No. 27

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	42.77	42.89	45.97	43.52	43.79
2	1.0	81.27	71.58	75.17	64.41	73.11
3	2.0	103.70	103.07	83.46	69.89	90.03
4	3.0	117.31	121.08	103.73	84.30	106.61
5	4.0	98.05	97.04	123.69	91.76	102.64
6	5.0	93.66	92.72	85.49	84.55	89.11
7	6.0	85.98	103.70	74.67	76.17	85.13
8	7.0	90.20	114.84	73.92	87.56	91.63
9	8.0	92.53	99.07	77.95	93.54	90.77
10	10.0	66.63	103.09	91.78	95.54	89.26

Mean Resistivity at ERT-27 is 86.21 Ohm - m.

ERT No. 28

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	30.77	28.89	31.71	29.20	30.14
2	1.0	18.87	17.61	18.24	15.73	17.61
3	2.0	27.65	11.31	21.37	17.60	19.48
4	3.0	39.61	11.32	32.06	20.75	25.94
5	4.0	40.22	12.57	27.65	22.63	25.77
6	5.0	37.72	12.57	28.29	22.00	25.15
7	6.0	33.94	15.08	26.40	26.40	25.46
8	7.0	30.80	13.20	30.80	26.40	25.30
9	8.0	25.15	20.12	30.17	25.15	25.15
10	10.0	31.43	18.86	25.14	25.14	25.14

Mean Resistivity at ERT-28 is 24.51 Ohm - m.

ERT No. 29

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	50.55	56.83	45.53	47.10	50.00
2	1.0	24.53	26.42	15.10	23.27	22.33
3	2.0	30.17	32.68	15.08	27.65	26.40
4	3.0	35.83	39.61	16.97	33.95	31.59
5	4.0	42.74	37.71	17.60	40.22	34.57
6	5.0	47.15	40.86	18.86	47.15	38.51
7	6.0	45.25	37.71	15.08	45.25	35.82
8	7.0	39.60	39.60	22.00	44.00	36.30
9	8.0	35.20	35.20	20.12	40.23	32.69
10	10.0	25.14	31.43	18.86	44.00	29.86

Mean Resistivity at ERT-29 is 33.81 Ohm - m.

ERT No. 30

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	107.39	131.88	128.74	125.29	123.33
2	1.0	74.85	86.17	89.32	94.35	86.17
3	2.0	42.74	31.43	36.45	42.74	38.34
4	3.0	30.18	28.29	45.26	37.72	35.36
5	4.0	30.17	25.14	35.20	42.74	33.31
6	5.0	34.57	22.00	37.72	44.00	34.57
7	6.0	37.71	18.86	37.71	45.25	34.88
8	7.0	30.80	26.40	35.20	44.00	34.10
9	8.0	25.15	25.15	35.20	40.23	31.43
10	10.0	18.86	25.14	31.43	31.43	26.72

Mean Resistivity at ERT-30 is 47.82 Ohm - m.

ERT No. 31

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	32.81	50.87	26.66	28.92	34.82
2	1.0	26.48	25.91	25.91	26.67	26.24
3	2.0	24.39	24.89	51.79	24.26	31.33
4	3.0	22.63	23.01	23.76	23.01	23.10
5	4.0	26.65	25.64	26.40	25.39	26.02
6	5.0	28.60	27.03	31.12	27.97	28.68
7	6.0	29.79	29.41	32.43	29.04	30.17
8	7.0	31.24	28.60	33.00	27.28	30.03
9	8.0	33.69	23.64	30.68	26.15	28.54
10	10.0	31.43	27.66	35.20	30.80	31.27

Mean Resistivity at ERT-31 is 29.02 Ohm - m.

ERT No. 32

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	16.14	15.45	15.35	14.19	15.28
2	1.0	13.59	13.78	13.15	13.40	13.48
3	2.0	12.82	13.95	13.70	13.07	13.39
4	3.0	15.09	13.58	14.90	13.96	14.38
5	4.0	16.09	15.34	15.08	14.08	15.15
6	5.0	17.60	16.34	18.54	16.97	17.36
7	6.0	18.10	16.97	19.23	17.72	18.01
8	7.0	21.12	19.36	22.00	20.24	20.68
9	8.0	21.12	20.12	24.14	22.63	22.00
10	10.0	25.14	24.51	24.14	27.03	25.21

Mean Resistivity at ERT-32 is 17.49 Ohm - m.

ERT No. 33

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	102.87	97.03	111.78	108.96	105.16
2	1.0	103.53	135.86	69.82	70.45	94.92
3	2.0	48.27	40.48	55.31	57.32	50.35
4	3.0	34.33	29.04	32.82	34.70	32.72
5	4.0	42.24	11.06	38.21	43.74	33.81
6	5.0	47.77	25.77	40.23	45.26	39.76
7	6.0	47.51	25.64	39.22	49.02	40.35
8	7.0	47.52	27.28	39.60	46.64	40.26
9	8.0	48.28	29.17	39.23	49.28	41.49
10	10.0	46.52	35.20	45.26	52.80	44.95

Mean Resistivity at ERT-33 is 52.38 Ohm - m.

ERT No. 34

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	16.52	16.17	14.26	16.33	15.82
2	1.0	13.78	16.35	14.22	14.53	14.72
3	2.0	14.71	15.84	15.46	17.10	15.78
4	3.0	15.84	16.22	16.60	17.16	16.46
5	4.0	18.10	16.09	18.11	21.87	18.54
6	5.0	18.86	19.49	20.43	22.32	20.28
7	6.0	21.12	22.63	22.25	23.38	22.35
8	7.0	23.76	24.64	24.64	24.20	24.31
9	8.0	26.65	26.15	24.64	25.15	25.65
10	10.0	31.43	30.80	28.92	28.29	29.86

Mean Resistivity at ERT-34 is 20.38 Ohm - m.

ERT No. 35

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	65.12	67.07	65.37	64.37	65.48
2	1.0	45.67	45.79	49.19	48.31	47.24
3	2.0	24.39	37.21	38.21	39.22	34.76
4	3.0	36.59	35.46	37.34	35.83	36.31
5	4.0	37.21	34.69	35.70	34.19	35.45
6	5.0	42.74	32.06	44.63	40.86	40.07
7	6.0	41.48	25.64	41.48	44.50	38.28
8	7.0	43.12	28.16	44.88	49.28	41.36
9	8.0	42.24	31.18	48.28	48.28	42.50
10	10.0	45.26	36.46	49.03	44.00	43.69

Mean Resistivity at ERT-35 is 42.51 Ohm - m.

ERT No. 36

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	83.52	53.38	75.05	57.15	67.28
2	1.0	35.85	33.97	37.11	40.26	36.80
3	2.0	23.88	25.14	35.20	36.45	30.17
4	3.0	28.29	32.06	47.15	39.61	36.78
5	4.0	32.68	35.20	52.79	47.77	42.11
6	5.0	31.43	34.57	56.57	50.29	43.22
7	6.0	30.17	37.71	52.79	52.79	43.37
8	7.0	35.20	35.20	48.40	48.40	41.80
9	8.0	35.20	35.20	45.26	45.26	40.23
10	10.0	31.43	44.00	37.72	44.00	39.29

Mean Resistivity at ERT-36 is 42.10 Ohm - m.

ERT No. 37

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	25.62	26.27	28.32	26.38	26.65
2	1.0	29.19	28.24	31.39	29.50	29.58
3	2.0	33.32	34.06	33.94	33.44	33.69
4	3.0	21.12	22.44	25.46	26.78	23.95
5	4.0	27.65	29.16	30.67	34.19	30.42
6	5.0	33.92	35.20	37.40	40.23	36.69
7	6.0	38.84	40.35	42.24	42.24	40.92
8	7.0	44.00	45.76	47.96	17.96	38.92
9	8.0	45.76	46.27	47.27	49.79	47.27
10	10.0	54.69	55.95	59.09	56.57	56.58

Mean Resistivity at ERT-37 is 36.47 Ohm - m.

ERT No. 38

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	6.31	6.09	9.39	10.68	8.12
2	1.0	11.07	10.32	11.20	4.46	9.26
3	2.0	12.95	11.06	13.20	9.80	11.75
4	3.0	16.03	10.56	15.84	13.01	13.86
5	4.0	19.86	12.57	19.36	13.07	16.22
6	5.0	20.12	12.89	19.80	13.20	16.50
7	6.0	21.87	12.07	21.12	15.46	17.63
8	7.0	19.80	13.20	18.92	17.16	17.27
9	8.0	18.10	14.08	19.61	18.10	17.47
10	10.0	21.37	16.97	22.63	20.74	20.43

Mean Resistivity at ERT-38 is 14.85 Ohm - m.

ERT No. 39

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	7.85	7.66	8.32	8.82	8.16
2	1.0	5.72	5.47	5.60	5.85	5.66
3	2.0	8.80	9.18	9.30	9.55	9.21
4	3.0	11.13	10.37	11.50	11.88	11.22
5	4.0	13.83	10.81	14.58	14.83	13.51
6	5.0	16.34	13.20	17.60	17.92	16.27
7	6.0	18.86	12.07	19.23	19.61	17.44
8	7.0	20.24	13.20	20.68	21.56	18.92
9	8.0	20.62	14.08	21.62	17.60	18.48
10	10.0	23.89	16.97	23.89	21.37	21.53

Mean Resistivity at ERT-39 is 14.04 Ohm - m.

ERT No. 40

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	51.43	55.42	46.16	48.23	50.31
2	1.0	40.63	38.68	16.23	49.69	36.31
3	2.0	35.32	32.68	35.45	31.30	33.69
4	3.0	37.91	22.63	27.35	24.71	28.15
5	4.0	33.94	21.62	26.40	20.36	25.58
6	5.0	27.97	22.00	28.60	23.26	25.46
7	6.0	28.28	19.23	30.17	23.76	25.36
8	7.0	27.28	21.12	33.00	23.76	26.29
9	8.0	28.16	23.64	33.69	25.65	27.79
10	10.0	31.43	28.29	37.09	28.91	31.43

Mean Resistivity at ERT-40 is 31.04 Ohm - m.

ERT No. 41

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	118.69	111.78	103.31	102.05	108.96
2	1.0	83.03	77.37	104.41	107.56	93.09
3	2.0	41.48	45.25	44.00	89.25	55.00
4	3.0	50.92	47.15	58.47	71.67	57.05
5	4.0	60.34	55.31	62.85	62.85	60.34
6	5.0	50.29	59.72	66.00	44.00	55.00
7	6.0	41.48	64.11	64.11	42.25	52.99
8	7.0	44.00	66.00	44.00	44.00	49.50
9	8.0	40.23	60.35	45.26	40.23	46.52
10	10.0	44.00	37.72	50.29	37.72	42.43

Mean Resistivity at ERT-41 is 62.09 Ohm - m.

ERT No. 42

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	117.75	295.16	185.26	197.19	198.84
2	1.0	20.76	88.06	23.90	55.98	47.18
3	2.0	33.94	45.51	36.45	38.97	38.72
4	3.0	45.26	41.49	50.29	50.29	46.83
5	4.0	52.79	47.77	55.31	52.79	52.17
6	5.0	56.57	47.15	59.72	53.43	54.22
7	6.0	49.02	52.79	56.56	45.25	50.91
8	7.0	52.80	48.40	52.80	52.80	51.70
9	8.0	45.26	45.26	50.29	50.29	47.78
10	10.0	37.72	44.00	56.57	50.29	47.15

Mean Resistivity at ERT-42 is 63.55 Ohm - m.

ERT No. 43

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	22.67	23.99	22.36	21.85	22.72
2	1.0	24.66	20.38	16.67	21.51	20.81
3	2.0	20.74	16.72	17.10	18.60	18.29
4	3.0	17.35	17.16	19.05	17.73	17.82
5	4.0	19.86	18.86	19.61	19.36	19.42
6	5.0	17.29	20.12	20.43	19.17	19.25
7	6.0	20.36	21.87	20.74	17.72	20.17
8	7.0	21.12	25.96	24.64	19.80	22.88
9	8.0	22.13	22.13	20.62	21.12	21.50
10	10.0	25.77	25.14	23.26	24.52	24.67

Mean Resistivity at ERT-43 is 20.75 Ohm - m.

ERT No. 44

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	38.09	47.63	32.97	38.31	39.25
2	1.0	47.18	46.42	38.99	51.33	45.98
3	2.0	36.20	36.70	37.84	36.58	36.83
4	3.0	27.91	27.91	33.01	28.67	29.38
5	4.0	24.13	24.39	25.64	24.39	24.64
6	5.0	25.46	25.77	28.29	26.72	26.56
7	6.0	26.40	27.53	24.89	27.53	26.59
8	7.0	25.08	27.28	28.16	29.04	27.39
9	8.0	27.16	30.17	30.68	29.17	29.30
10	10.0	32.69	35.20	35.83	33.94	34.42

Mean Resistivity at ERT-44 is 32.03 Ohm - m.

ERT No. 45

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	81.14	66.44	70.34	76.62	73.64
2	1.0	36.10	25.03	25.41	24.91	27.86
3	2.0	16.09	16.84	16.59	14.58	16.03
4	3.0	15.47	15.09	16.22	16.97	15.94
5	4.0	17.10	18.10	18.10	19.61	18.23
6	5.0	20.12	20.74	20.12	19.49	20.12
7	6.0	20.36	21.87	22.63	22.63	21.87
8	7.0	21.12	22.88	21.12	23.76	22.22
9	8.0	21.12	23.13	20.11	24.14	22.13
10	10.0	25.14	26.40	22.63	27.66	25.46

Mean Resistivity at ERT-45 is 26.35 Ohm - m.

ERT No. 46

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	37.68	32.03	39.25	37.05	36.50
2	1.0	18.50	12.58	15.73	21.39	17.05
3	2.0	23.88	15.08	26.40	27.65	23.25
4	3.0	24.52	13.20	32.06	35.83	26.40
5	4.0	27.65	15.08	35.20	40.22	29.54
6	5.0	31.43	15.72	34.57	44.00	31.43
7	6.0	33.94	22.63	37.71	41.48	33.94
8	7.0	30.80	22.00	35.20	30.80	29.70
9	8.0	30.17	25.15	30.17	25.15	27.66
10	10.0	31.43	25.14	31.43	25.14	28.29

Mean Resistivity at ERT-46 is 28.38 Ohm - m.

ERT No. 47

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	306.15	257.48	240.21	242.41	261.56
2	1.0	372.37	322.05	327.08	393.13	353.66
3	2.0	385.90	390.93	268.99	257.69	325.88
4	3.0	256.50	228.21	211.23	216.89	228.21
5	4.0	98.05	191.06	165.92	188.55	160.90
6	5.0	50.29	66.00	163.44	210.58	122.58
7	6.0	41.48	64.11	154.61	147.07	101.82
8	7.0	44.00	66.00	132.00	92.40	83.60
9	8.0	40.23	60.35	110.64	80.46	72.92
10	10.0	44.00	56.57	113.15	69.15	70.72

Mean Resistivity at ERT-47 is 178.18 Ohm - m.

ERT No. 48

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	81.64	80.07	80.38	95.77	84.47
2	1.0	50.32	47.18	50.29	40.89	47.17
3	2.0	35.20	35.20	32.68	36.45	34.88
4	3.0	22.63	26.40	15.09	24.52	22.16
5	4.0	27.65	30.17	15.08	20.11	23.25
6	5.0	28.29	31.43	15.72	18.86	23.58
7	6.0	30.17	30.17	18.86	18.86	24.52
8	7.0	30.80	30.80	17.60	22.00	25.30
9	8.0	30.17	25.15	20.12	20.12	23.89
10	10.0	25.14	25.14	18.86	18.86	22.00

Mean Resistivity at ERT-48 is 33.12 Ohm - m.

ERT No. 49

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	121.83	100.48	72.85	73.79	92.24
2	1.0	64.79	69.19	58.50	56.61	62.27
3	2.0	91.76	101.82	74.16	76.68	86.11
4	3.0	84.87	132.02	81.10	84.87	95.72
5	4.0	95.53	123.19	82.96	98.05	99.93
6	5.0	100.58	113.15	94.29	113.15	105.29
7	6.0	109.36	120.67	101.82	116.90	112.19
8	7.0	118.80	118.80	105.60	118.80	115.50
9	8.0	125.73	115.67	105.61	125.73	118.19
10	10.0	144.58	138.29	125.72	144.58	138.29

Mean Resistivity at ERT-49 is 102.57 Ohm - m.

ERT No. 50

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	215.09	230.16	234.56	213.21	223.26
2	1.0	198.76	189.96	200.65	190.59	194.99
3	2.0	105.59	103.07	111.87	116.90	109.36
4	3.0	92.41	101.84	90.53	99.96	96.19
5	4.0	50.28	60.34	62.85	70.39	60.97
6	5.0	40.86	50.29	47.15	53.43	47.93
7	6.0	33.94	41.48	37.71	49.02	40.54
8	7.0	30.80	39.60	35.20	35.20	35.20
9	8.0	25.15	30.17	35.20	30.17	30.17
10	10.0	25.14	31.43	25.14	18.86	25.14

Mean Resistivity at ERT-50 is 86.37 Ohm - m.

ERT No. 51

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	21.57	23.55	25.75	21.82	23.17
2	1.0	35.85	34.09	36.80	34.28	35.26
3	2.0	50.91	45.13	38.97	39.97	43.75
4	3.0	53.56	54.13	53.19	56.39	54.32
5	4.0	65.11	58.58	63.86	60.84	62.10
6	5.0	74.17	66.32	74.49	72.92	71.98
7	6.0	79.57	72.78	77.31	82.58	78.06
8	7.0	84.04	82.28	82.28	84.48	83.27
9	8.0	80.97	85.49	83.48	84.49	83.61
10	10.0	84.86	91.15	75.43	75.43	81.72

Mean Resistivity at ERT-51 is 61.72 Ohm - m.

ERT No. 52

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	125.29	108.52	108.20	96.90	109.73
2	1.0	121.65	116.87	125.17	129.57	123.32
3	2.0	169.70	148.07	107.60	114.39	134.94
4	3.0	176.91	185.58	150.50	151.63	166.16
5	4.0	213.19	188.55	156.87	156.37	178.75
6	5.0	172.87	186.69	179.15	166.57	176.32
7	6.0	165.92	166.68	166.68	171.96	167.81
8	7.0	196.13	174.24	175.12	170.72	179.05
9	8.0	169.98	159.92	188.08	189.09	176.77
10	10.0	192.35	186.07	188.58	198.63	191.41

Mean Resistivity at ERT-52 is 160.42 Ohm - m.

ERT No. 53

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	76.62	84.15	93.95	107.01	90.43
2	1.0	96.11	95.48	95.60	96.11	95.83
3	2.0	153.10	126.20	75.17	78.69	108.29
4	3.0	284.03	130.13	87.51	107.50	152.29
5	4.0	176.99	126.71	102.57	136.76	135.76
6	5.0	155.89	133.26	126.35	135.78	137.82
7	6.0	157.63	137.26	147.82	123.69	141.60
8	7.0	157.52	134.64	93.28	95.04	120.12
9	8.0	146.85	135.78	86.50	84.49	113.41
10	10.0	80.46	56.57	61.60	60.35	64.75

Mean Resistivity at ERT-53 is 116.03 Ohm - m.

ERT No. 54

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	176.47	174.27	169.56	163.28	170.90
2	1.0	152.85	170.46	176.12	152.22	162.91
3	2.0	104.33	109.36	118.16	105.59	109.36
4	3.0	88.64	148.99	98.07	135.79	117.87
5	4.0	113.13	140.78	123.19	143.30	130.10
6	5.0	119.43	160.29	138.29	154.01	143.01
7	6.0	124.44	181.01	120.67	158.38	146.13
8	7.0	140.80	198.00	127.60	149.60	154.00
9	8.0	145.84	196.13	125.63	145.84	153.36
10	10.0	163.44	207.44	132.01	169.72	168.15

Mean Resistivity at ERT-54 is 145.58 Ohm - m.

ERT No. 55

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	194.68	276.32	298.30	262.19	257.87
2	1.0	274.87	221.41	272.36	244.05	253.17
3	2.0	258.94	216.20	329.33	243.86	262.08
4	3.0	220.66	226.32	354.57	211.23	253.20
5	4.0	198.61	193.58	170.95	201.12	191.07
6	5.0	166.58	191.72	182.29	176.01	179.15
7	6.0	147.07	162.15	233.80	150.84	173.47
8	7.0	154.00	145.20	237.60	158.40	173.80
9	8.0	130.75	145.84	251.45	165.96	173.50
10	10.0	106.86	150.86	201.15	132.01	147.72

Mean Resistivity at ERT-55 is 206.50 Ohm - m.

ERT No. 56

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	169.56	185.57	170.19	174.90	175.06
2	1.0	91.21	116.99	113.22	96.24	104.42
3	2.0	81.71	94.28	104.33	94.28	93.65
4	3.0	98.07	101.84	135.79	111.27	111.74
5	4.0	125.70	130.73	135.76	115.64	126.96
6	5.0	144.58	150.86	141.44	122.58	139.87
7	6.0	113.13	131.99	147.07	135.76	131.99
8	7.0	118.80	127.60	136.40	132.00	128.70
9	8.0	120.70	125.73	145.84	135.78	132.01
10	10.0	138.29	144.58	157.15	150.86	147.72

Mean Resistivity at ERT-56 is 129.21 Ohm - m.

ERT No. 57

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	334.10	279.46	319.97	288.88	305.60
2	1.0	316.39	258.52	323.31	320.79	304.75
3	2.0	296.65	321.79	301.68	304.19	306.08
4	3.0	239.52	269.70	245.18	265.93	255.08
5	4.0	193.58	304.19	233.80	223.75	238.83
6	5.0	220.01	270.30	235.73	220.01	236.51
7	6.0	237.57	290.37	226.26	241.34	248.89
8	7.0	215.60	264.00	233.20	228.80	235.40
9	8.0	226.31	271.57	231.33	231.33	240.14
10	10.0	251.44	308.01	232.58	245.15	259.30

Mean Resistivity at ERT-57 is 263.06 Ohm - m.

ERT No. 58

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	0.50	41.76	58.72	59.66	58.40	54.64
2	1.0	55.98	72.96	58.50	54.72	60.54
3	2.0	72.91	56.57	74.16	70.39	68.51
4	3.0	56.58	50.92	52.81	58.47	54.70
5	4.0	22.63	40.22	47.77	45.25	38.97
6	5.0	18.86	44.00	50.29	47.15	40.08
7	6.0	15.08	41.48	49.02	41.48	36.77
8	7.0	22.00	39.60	52.80	39.60	38.50
9	8.0	30.17	35.20	50.29	40.23	38.97
10	10.0	18.86	31.43	50.29	37.72	34.58

Mean Resistivity at ERT-58 is 46.62 Ohm - m.

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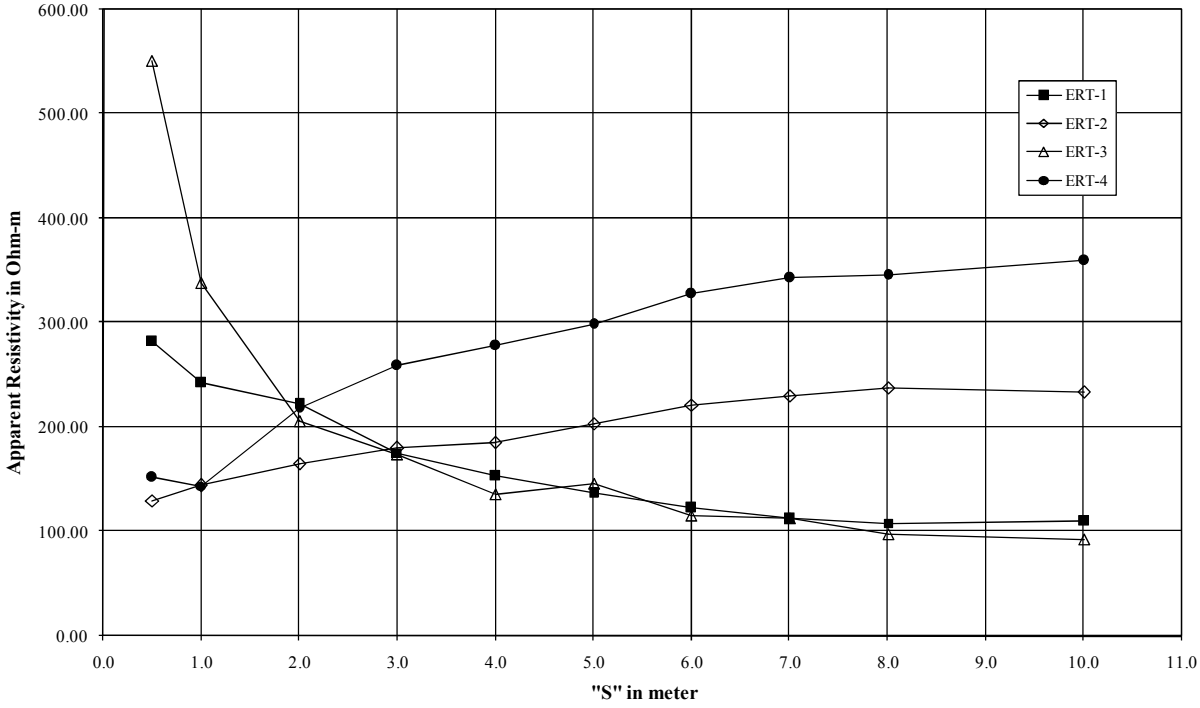

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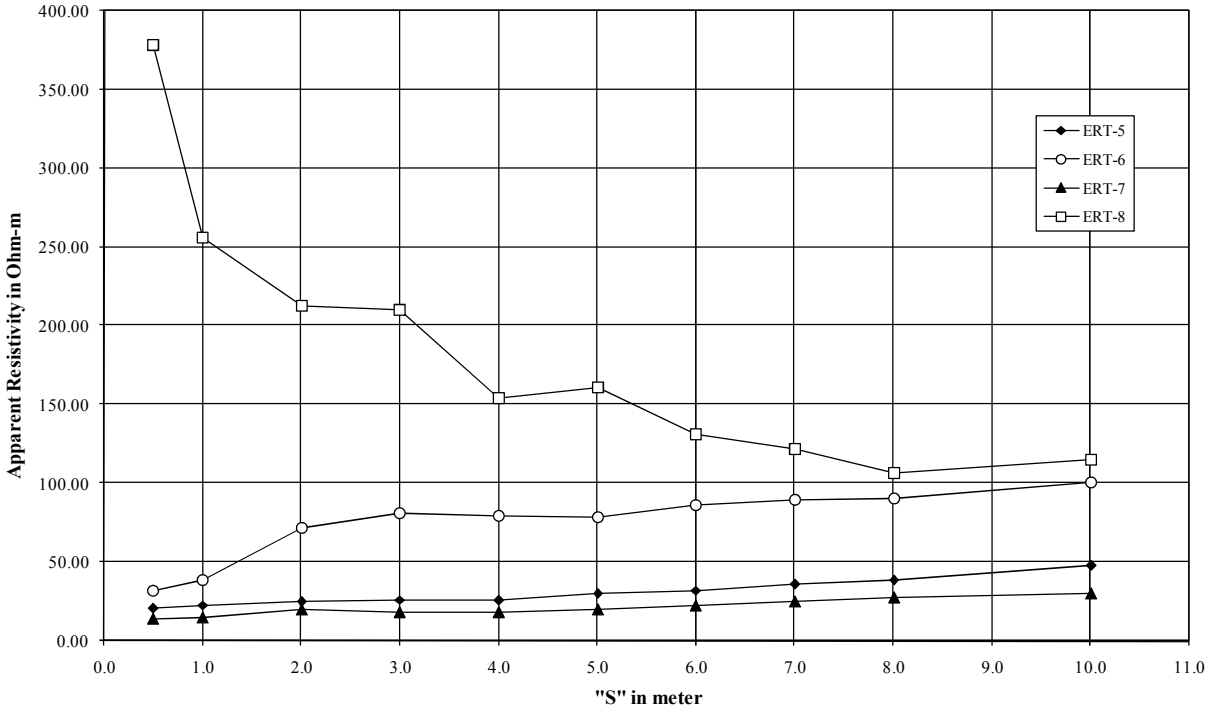

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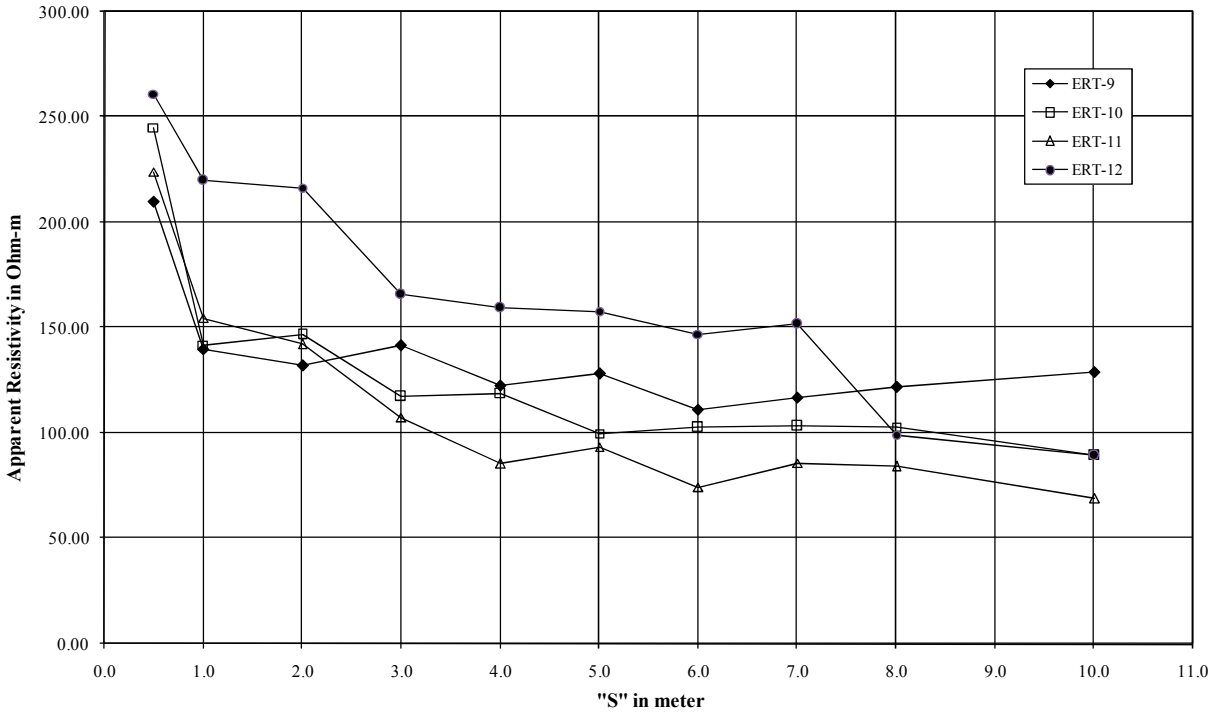

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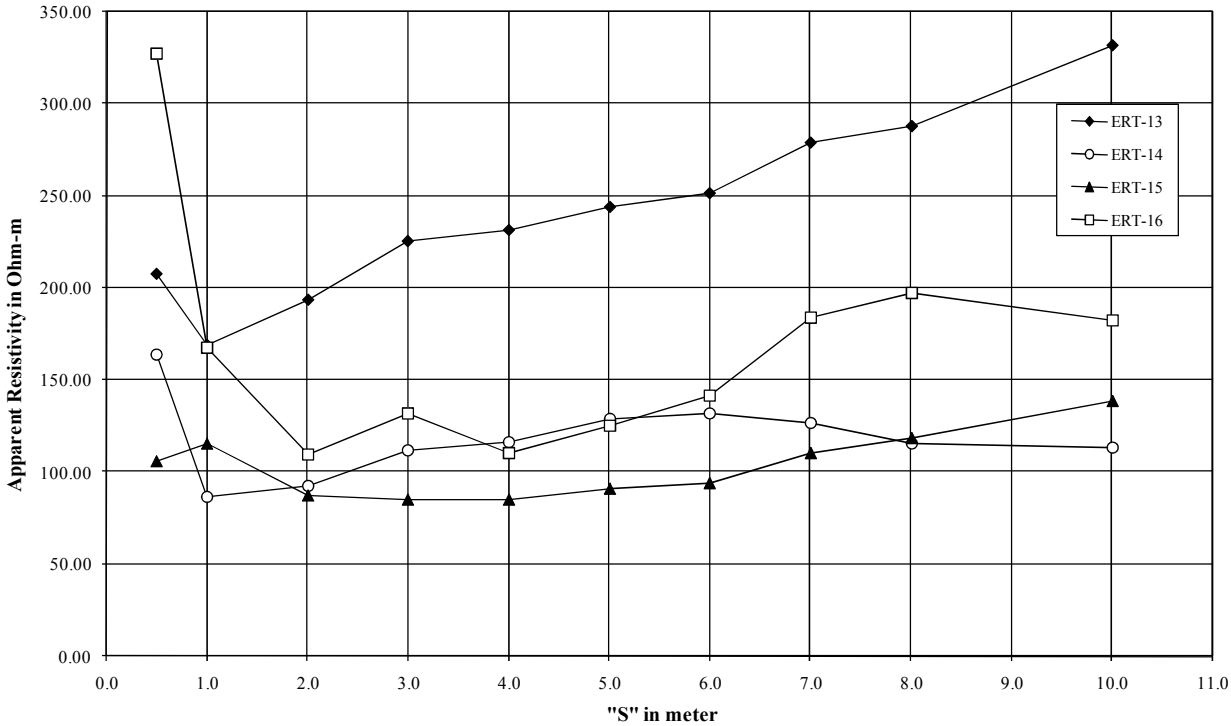

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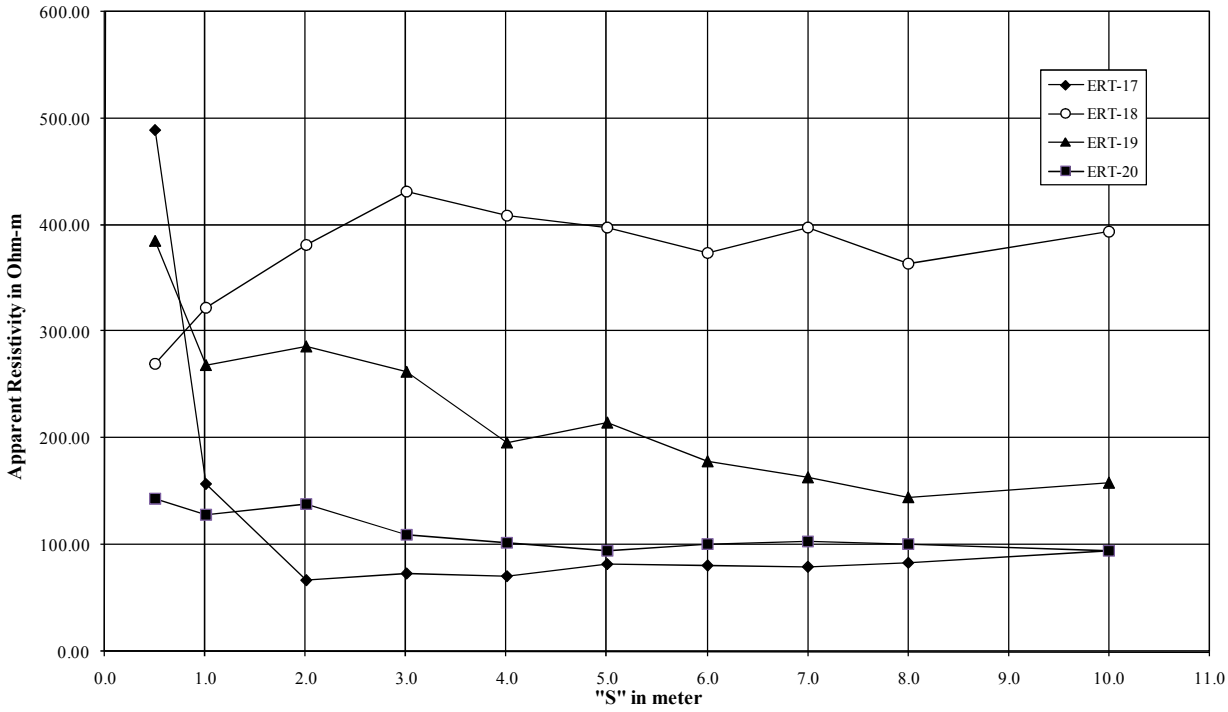

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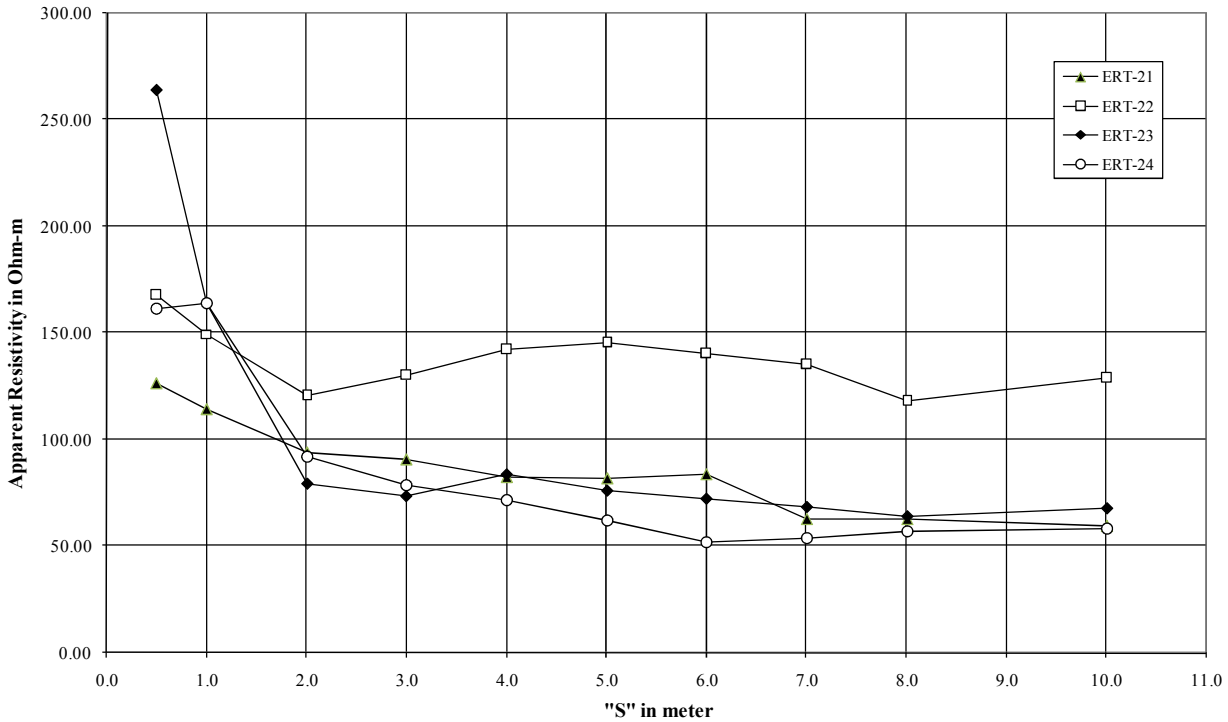

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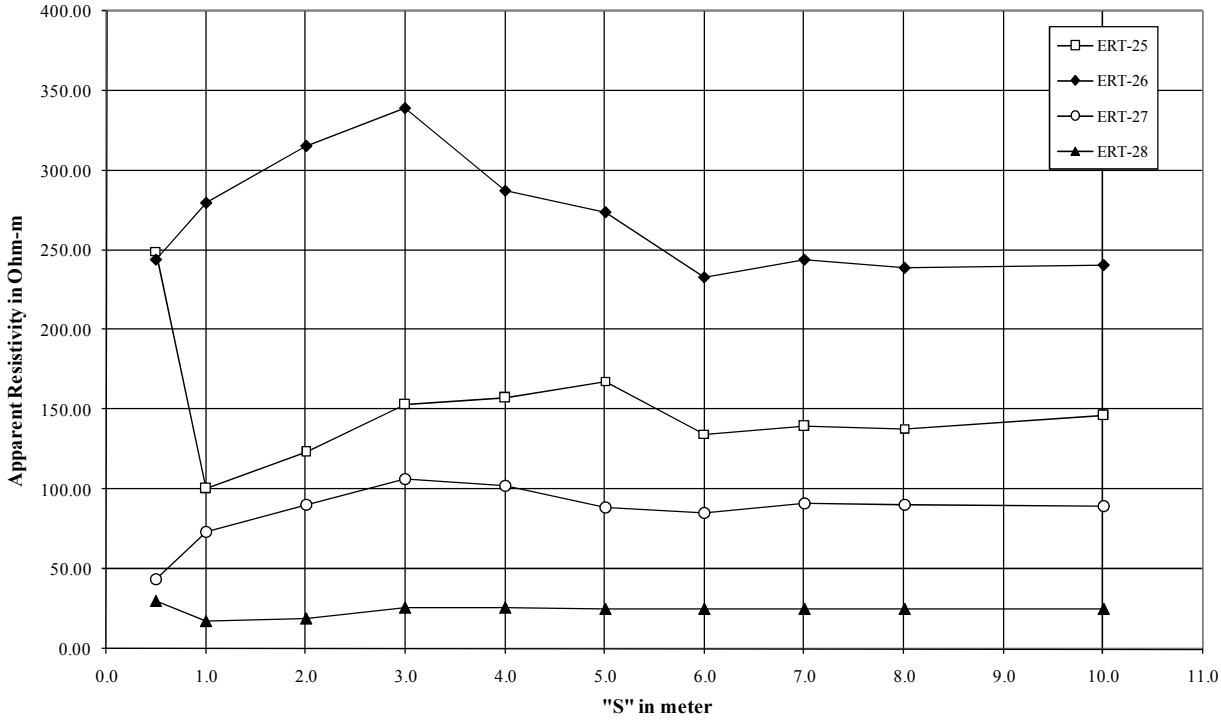

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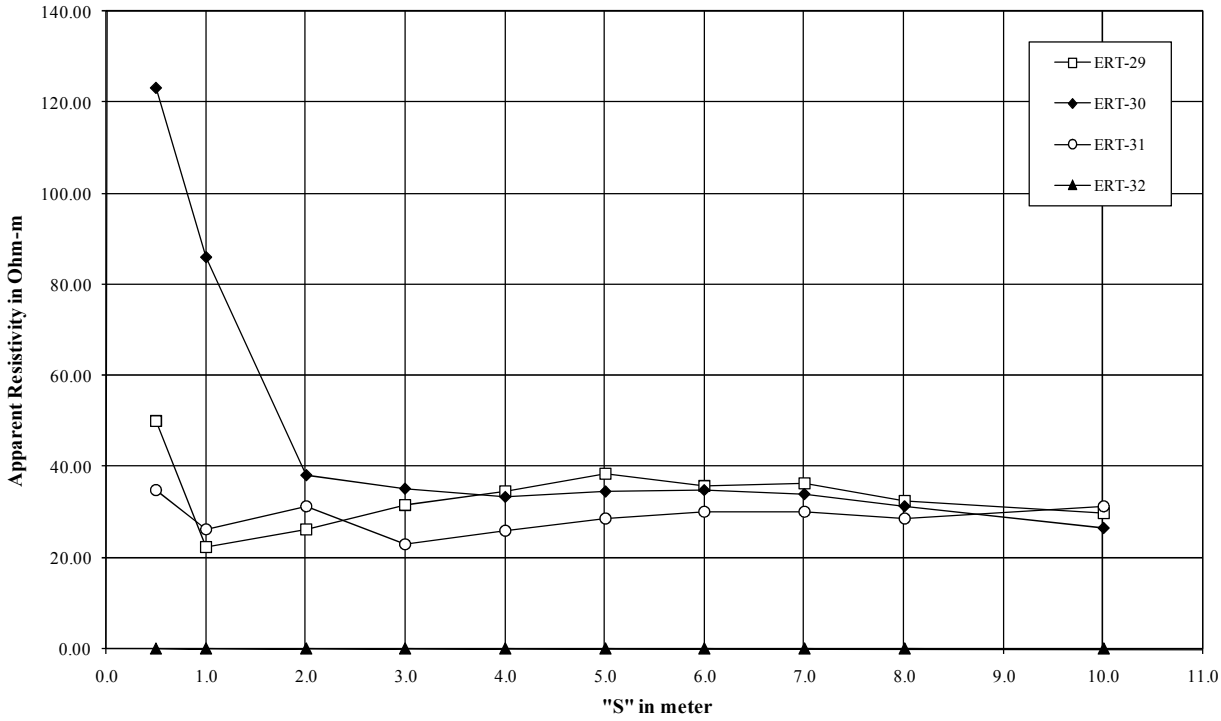

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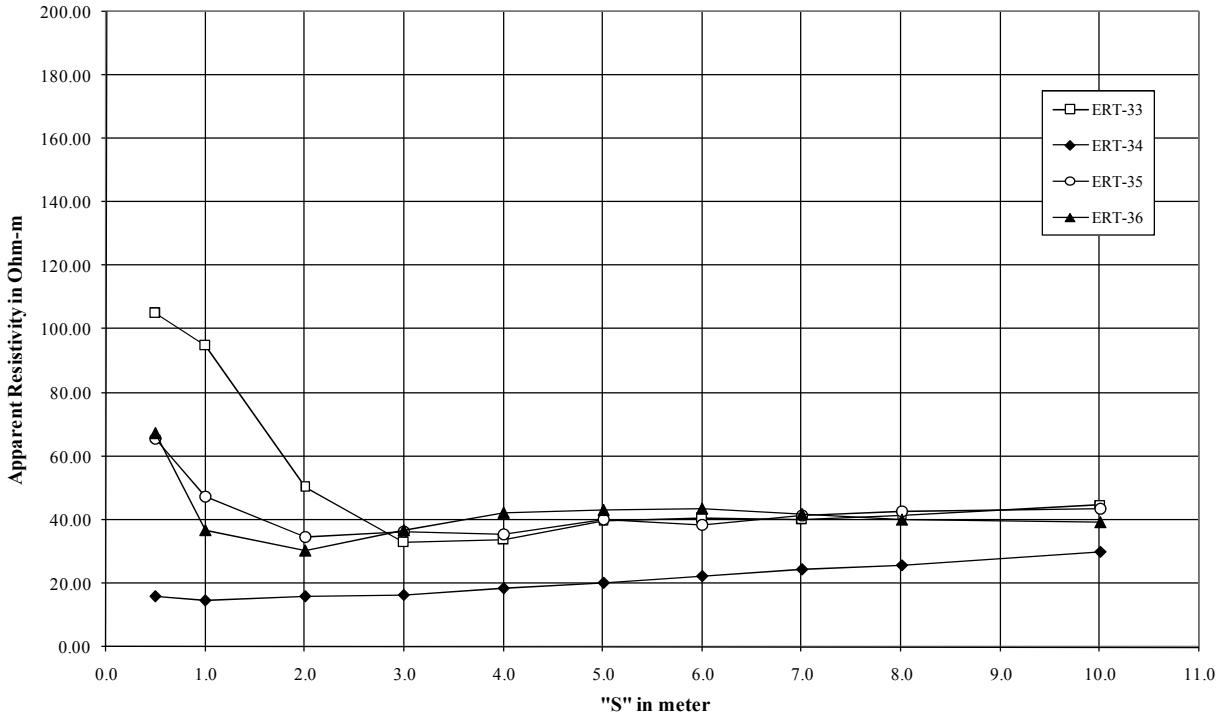

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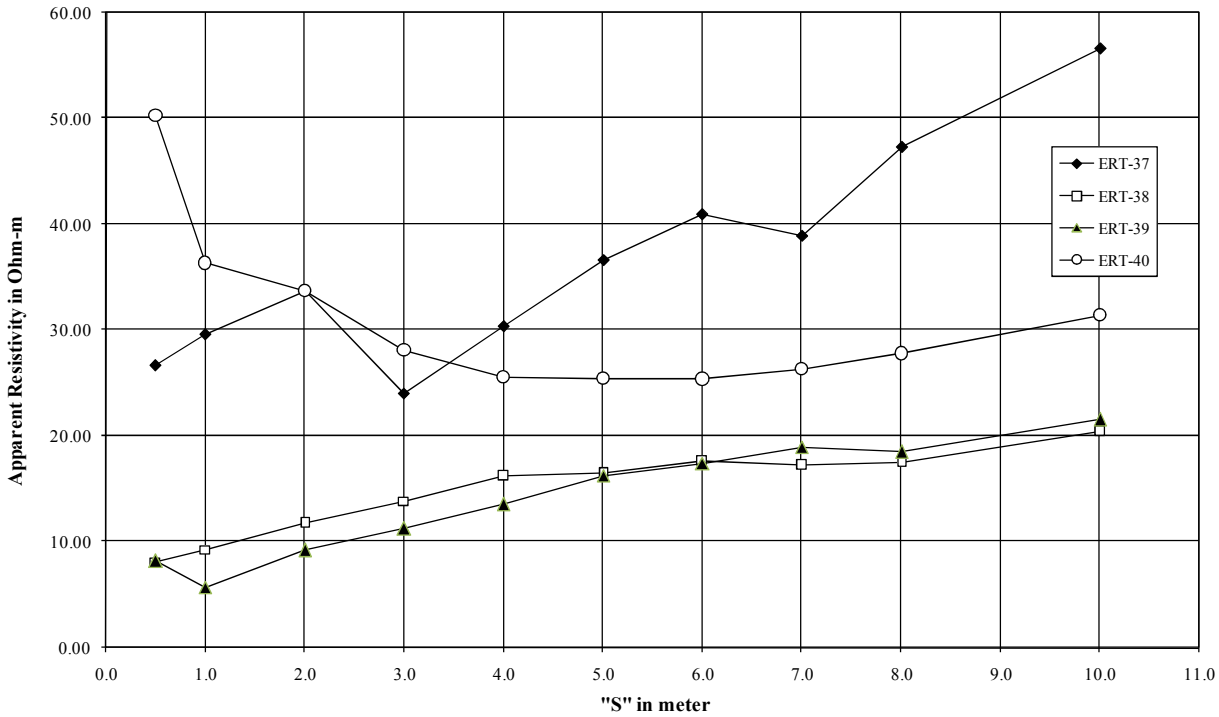
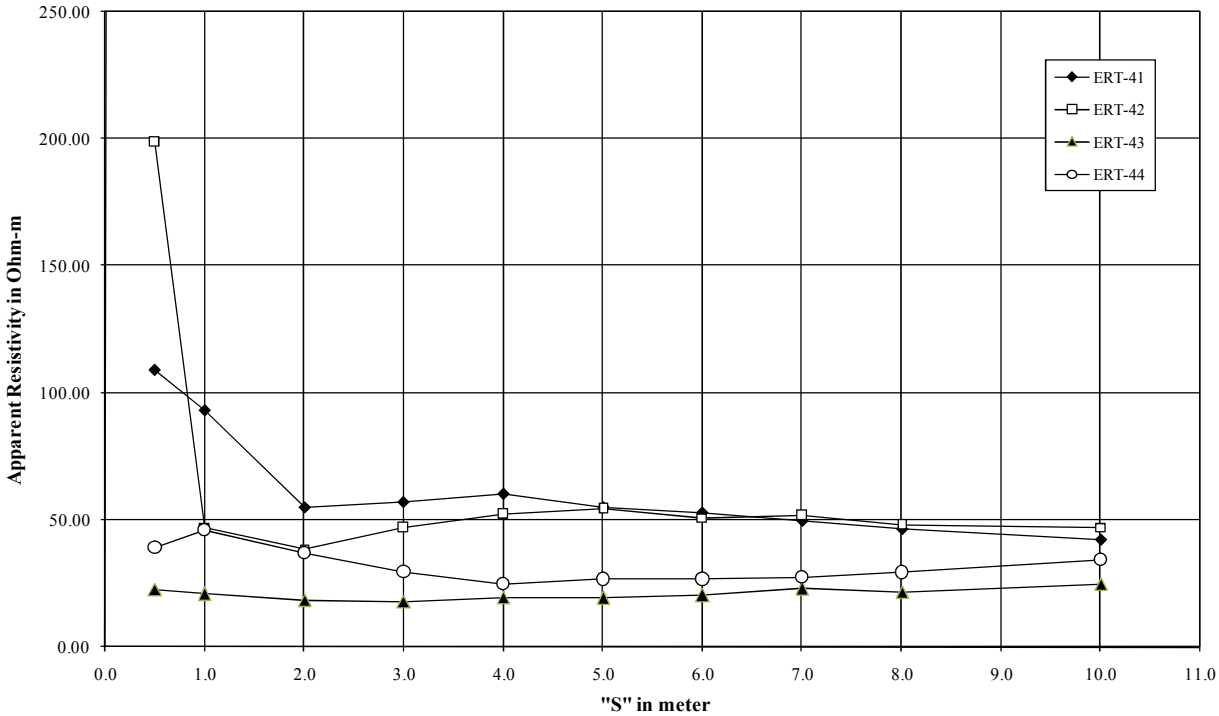


Apparent Resistivity Curves



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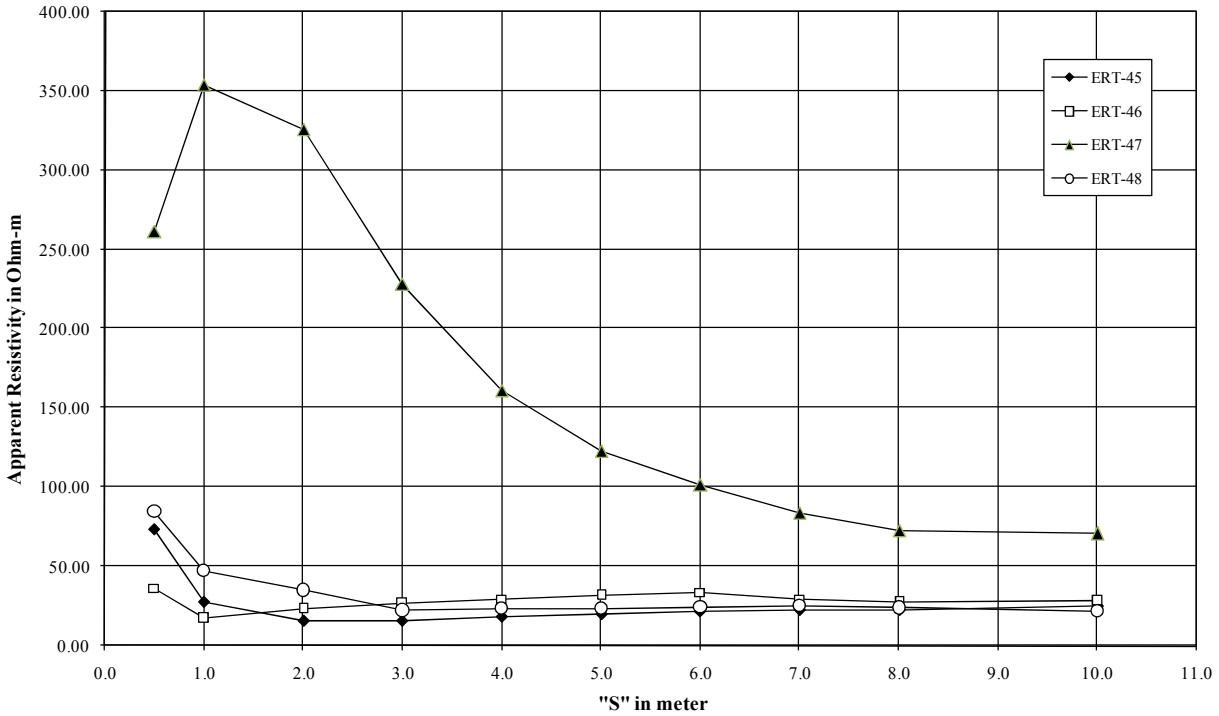

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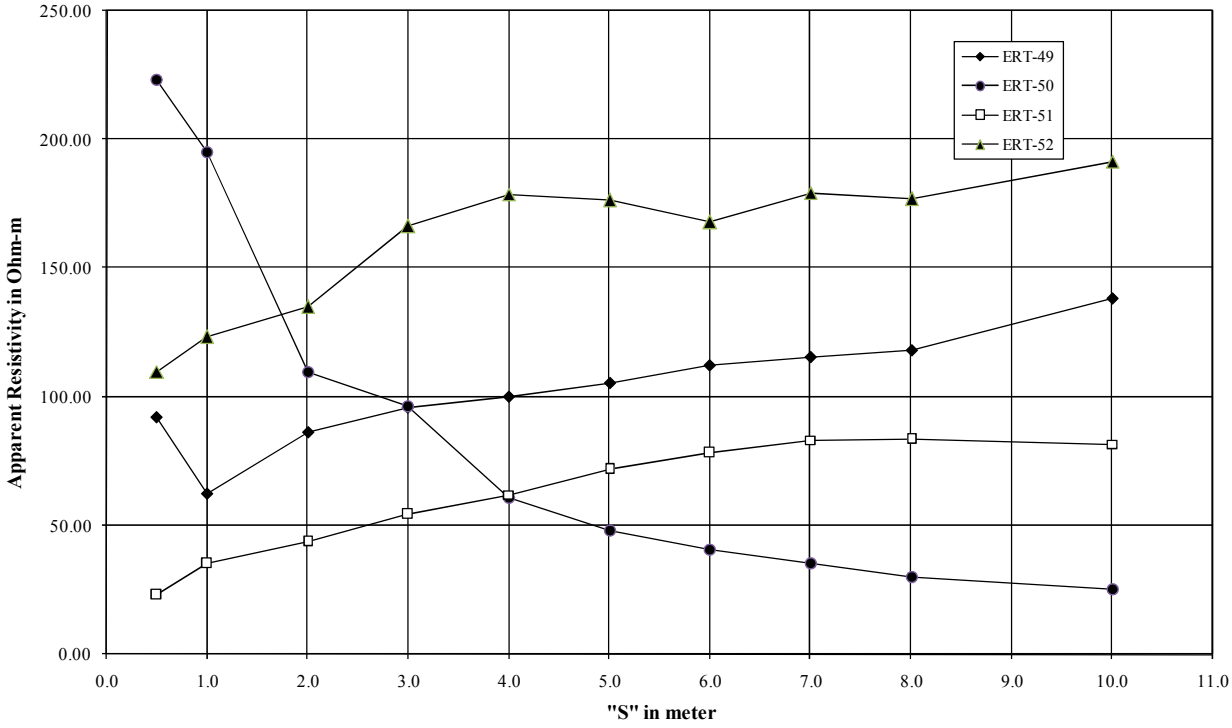

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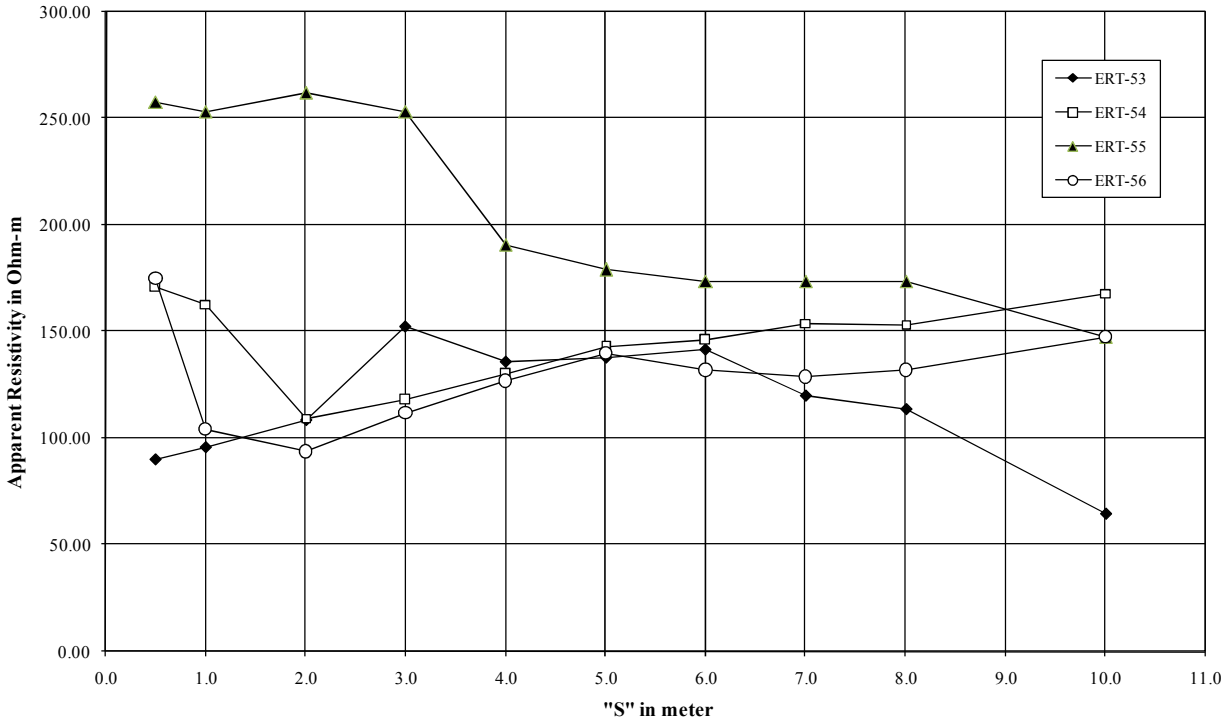
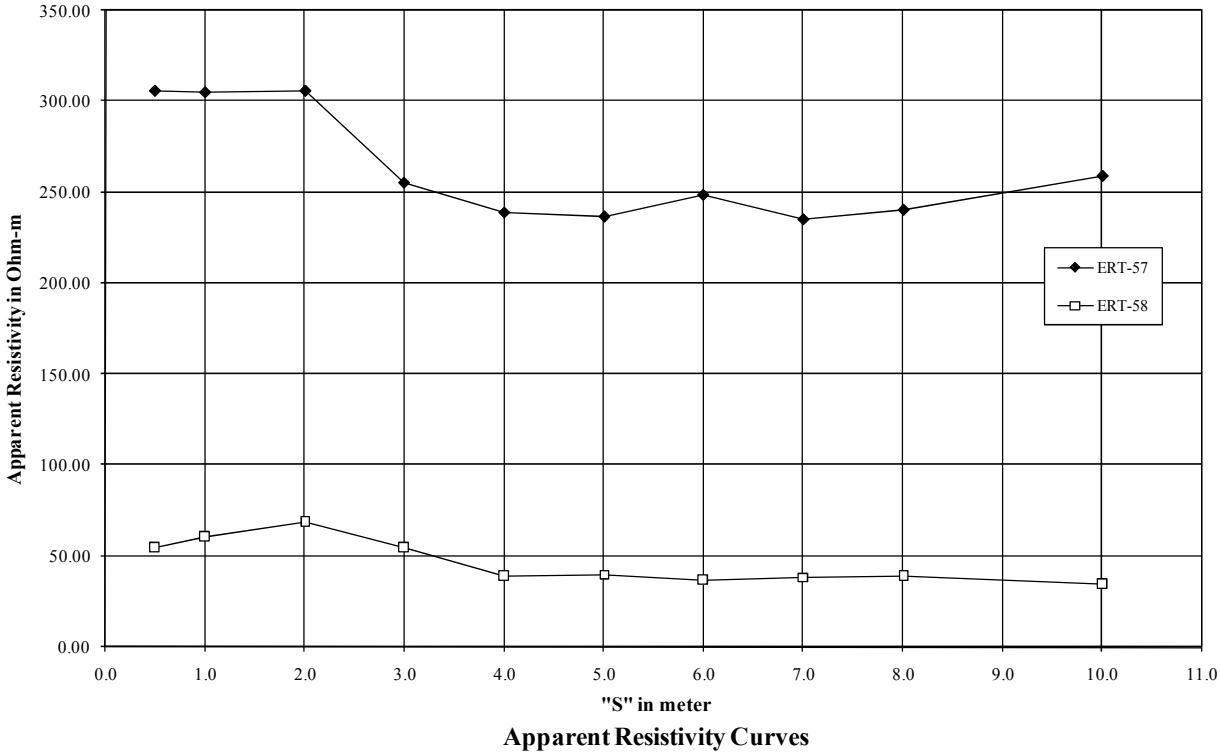


Apparent Resistivity Curves



Apparent Resistivity Curves

PART II: LABORATORY TEST RESULTS

CETEST Engineering Consultants
An ISO 9001, 14001 & OHSAS 18001 Certified Company

C. E. Testing Company Pvt. Ltd.
(AN NABL ACCREDITED TESTING LABORATORY AS PER ISO/IEC 17025)
Sardarpara, Brahmapur,Kolkata-700 096,Tel: (033) 2410 5085/9813
E-mail: cetest.lab@gmail.com • Web: www.cetestindia.com
CIN: U74920WB1988PTC045778

Certificate No: T-2704

Format No: CET/FM/42

TEST REPORT

TEST REPORT NO : 4099 DATE: 24/05/2018

Name and Address of Customer: M/s. Bharat Heavy Electricals Limited,
Power Sector – Western Region,
Shreemohini Complex, 345 Kingsway,
Nagpur - 440001, India

Customer Reference No : BHE/PW/PUR/NTPRT-GEO/1833

Customer Reference Date : 08/01/2018

Date of Sample Received at Lab : 26/02/2018

Date of Starting of Test : 26/02/2018

Date of Completion of Test : 16/05/2018

Sample ID Nos : 4099/BH01/UDS01 to 4099/TP33/DS02

Please refer the page nos. 651 of 955 to 727of 955 of the Report for the following:

1. Sample Description
2. Test methods used
3. Test results

Further to note that the test parameters are mentioned at the header of test result table.

* The report related to the particular sample(s) tested under stated condition.
* All tests are based as per IS specifications.
* Any discrepancy in this report should be brought to the notice within 15 (fifteen) days from the date of certificate.
* Full/Partial use of this test results could not be done without the written permission of authorized signatory.

Bore Hole	Sample Number	Depth M	Sample Description	Bulk Dens. gms/cc	Dry Dens. gms/cc	Spec. Grav.	Nat. Mois. %	Void Ratio	Strength Test Results Pc/Pn kg/sqcm	Shear kg/sqcm	Cohesn kg/sqcm	Frictn Deg.	Atter. Limits LL %	PL %	SL %	IS Classification	Grain Size Gravl %	Sand %	Silt %	Clay %	Test Method
BH140	UDS01	1.00	Brownish grey clayey sandy silt with decomposed rock.	1.94	1.69	2.60	14 S 15 T 14 C	0.471	TRSH-UU 3.0 2.0 1.0	 1.105 0.935 0.709	0.43	9	44	19	13	CI		50	38	12	Do
BH140	SPT01	2.00	Brownish grey, silty sand with trcaes of clay binder and rock fragments.			2.71										SM	8	60	26	6	Do
BH140	SPT02	3.00	Brownish grey, silty sand with traces of clay binders.													SM		69	31(Silt+Clay)		Do
BH141	DS01	0.50	Brownish grey, clayey silt with sand mixture. Obs. rock pieces.														4	41	55(Silt+Clay)		Do
BH141	SPT01	1.00	Reddish brown, clayey silty sand with gravels.			2.65										SM	15	60	17	8	Do
BH142	DS01	0.50	Brownish grey, silty sand with clay binder & mica.			2.70										SM		58	33	9	Do
BH142	SPT01	1.00	Reddish brown, clayey silt / silty clay.										26	16		CL					Do
BH142	SPT02	2.50	Grey, silty sand with clay binder and mica.			2.68										SM		63	30	7	Do
BH143	DS01	0.50	Brownish grey, clayey silt with traces of sand mixture.			.							40	19		CI					Do
BH143	SPT01	1.00	Brownish grey, clayey sandy silt.			2.65										SM		53	36	11	Do
BH143	SPT02	2.25	Brownish grey, silty sand. Obs. mica.													SM-SP		93	7(Silt+Clay)		Do

Bore Hole	Sample Number	Depth M	Sample Description	Bulk Dens. gms/cc	Dry Dens. gms/cc	Spec. Grav.	Nat. Mois. %	Void Ratio	Strength Test Results Pc/Pn kg/sqcm	Shear kg/sqcm	Cohesn kg/sqcm	Frictn Deg.	Atter. Limits LL %	PL %	SL %	IS Classification	Grain Size Gravl %	Sand %	Silt %	Clay %	Test Method
BH144	SPT01	1.00	Light grey, silty sand with traces of clay binders. Obs rock pieces.													SM	7	55	38(Silt+Clay)		Do
BH144	UDS01	2.00	Brownish grey clayey silt with sand mixture.	1.88	1.43	2.53	28 S 32 T 25 C	0.701	TRSH-UU 3.0 2.0 1.0	 0.433 0.403 0.403	0.41	0	44	22	16	CI		26	71	3	Do
									UNCONFD 0.0 0.0 0.0	0.366 0.361 0.331	0.35	0									
									REMOULD 0.0 0.0 0.0	0.285 0.270 0.261	0.27	0									
BH144	SPT02	2.80	Brownish grey, silty sand with traces of clay binder & silt stone.													SM		81	19(Silt+Clay)		Do
BH145	SPT01	1.00	Yellowish grey, clayey silty sand.													SM		84	16(Silt+Clay)		Do
BH145	SPT02	3.00	Brownish grey, silty sand with rock pieces.													SM		74	26(Silt+Clay)		Do
BH146	SPT01	1.00	Brownish grey, clayey silt with sand mixture.			2.63												30	48	22	Do
BH146	SPT02	2.50	Brownish grey, silty sand.													SM		74	26(Silt+Clay)		Do
BH147	SPT01	1.00	Brownish grey, silty sand with decomposed rock.													SM		71	29(Silt+Clay)		Do

Bore Hole	Sample Number	Depth M	Sample Description	Bulk Dens. gms/cc	Dry Dens. gms/cc	Spec. Grav.	Nat. Mois. %	Void Ratio	Strength Test Results				Atter. Limits			IS	Grain Size			Test Method
									Pc/Pn kg/sqcm	Shear kg/sqcm	Cohesn kg/sqcm	Frictn Deg.	LL %	PL %	SL %	Classifi cation	Gravl %	Sand %	Silt %	Clay %	
BH148	DS01	0.50	Reddish brown, clayey sandy silt with kankars and moorum.			2.69										SM		50	38	12	Do
BH148	SPT01	1.00	Yellowish brown, silty clay with sand mixture.										37	18		CI					Do
BH148	SPT02	2.50	Reddish brown, clayey silty sand.			2.67										SM		66	27	7	Do
BH149	SPT01	1.00	Greyish brown, clayey silt with traces of sand mixture.										38	18		CI					Do
BH149	SPT02	3.00	Brownish grey, clayey silt with sand mixture.															37	63(Silt+Clay)		Do
BH150	SPT01	1.00	Brownish grey, clayey silt / silty clay.										60	24		CH					Do
BH150	UDS01	2.00	Brownish grey, clayey silt with sand mixture.	2.07	1.74	2.67	19 S 19 T 18 C	0.524	TRSH-UU 3.0 2.0 1.0 UNCONFD 0.0 0.0 0.0 REMOULD 0.0 0.0 0.0	1.345 1.135 0.925 0.674 0.615 0.610 0.502 0.493 0.451	0.60 0.63 0.48	10 0 0	30	15	13	CL		47	34	19	Do
BH150	SPT02	2.75	Dark grey, silty sand.													SM-SP		90	10(Silt+Clay)		Do
BH151	SPT01	1.00	Brownish grey, clayey silty sand.			2.65										SM		61	26	13	Do

BH No.	Run No.	Depth (M)	Density (gm/cc)		Water Content	Porosity %	Specific Gravity	Crushing Strength/ Unconfined Compressive strength (kg/sqcm)		Coefficient of softening	Point Load Strength Index (kg/sqcm)	Slake Durability Index (%)	Hardness (based on Mohs' Scale)	Soundness* (% Loss)	E (Kg/sqcm)	Test Method
			Bulk	Dry	(%)			Dry	Saturated							
BH131	10	13.50-14.25					2.901									Do
BH132	3	06.75-7.50					2.768									Do
BH132	30	27.00-27.75	2.780	2.778	0.09	0.4354	2.790		404							Do
BH134	4	5.25-6.00	2.543	2.539	0.17	0.5147	2.552				27.34					Do
BH135	7	7.50-8.25	2.426	2.422	0.14	0.5875	2.540				21.61					Do
BH136	11	11.00-11.75	2.426	2.422	0.14	0.5875	2.540				15.32					Do
BH136	15	14.00-15.00											Moderately Hard			Do
BH137	8	8.00-8.75	2.338	2.336	0.10	1.3444	2.367				19.29					Do
BH137	11	10.25-11.00	2.622	2.617	0.19	0.9200	2.641				26.43					Do
BH138	4	3.50-4.25	2.638	2.630	0.32	0.9553	2.655				34.92					Do
BH139	12	12.00-12.75	2.314	2.299	0.68	8.5667	2.514				5.41					Do
BH140	9	9.50-10.25	2.401	2.337	2.72	17.9725	2.849				0.92					Do
BH141	9	10.25-11.00											Moderately Hard			Do
BH141	13	13.25-14.00	2.733	2.704	1.06	6.6636	2.898				5.35					Do
BH142	8	8.25-9.00	1.968	1.889	4.18	66.0154	5.560				7.92					Do
BH143	7	7.00-7.5	2.522	2.516	0.24	0.9391	2.614				6.85					Do
BH144	7	7.75-8.50	2.597	2.540	2.26	10.0742	2.825				0.96					Do
BH145	8	9.00-9.75	2.465	2.449	0.66	8.1308	2.665				7.54					Do
BH146	12	11.50-12.25	2.415	2.383	1.36	7.1615	2.614				4.52					Do
BH147	4	3.50-4.25	2.456	2.450	0.25	1.1178	2.477				38.42					Do
BH147	12	9.50-10.25										82.39				Do
BH148	3	5.00-5.75	2.333	2.313	0.85	15.4125	2.735				14.56					Do
BH149	9	9.25-10.00	2.664	2.660	0.15	4.3230	2.774				28.99					Do
BH150	2	4.00-4.75	2.455	2.414	1.69	17.6316	2.931				17.48					Do
BH150	13	12.25-13.00											Moderaely Hard			Do
BH151	13	12.00-12.75	2.237	2.231	0.29	1.4286	2.615				17.85					Do
BH152	3	4.00-4.75	2.350	2.313	1.57	7.8933	2.607				0.90					Do
BH152	17	14.50-15.00										49.58				Do
BH153	6	6.75-7.50	2.636	2.631	0.20	1.1133	2.662		525							Do
BH153	16	14.25-15.00										97.94				Do
BH154	12	14.50-15.00	2.489	2.357	5.61	18.3125	2.885				2.43					Do
BH155	10	9.25-10.00	2.748	2.699	1.85	13.2273	2.781				0.96					Do
BH155	23	19.00-20.00	2.647	2.592	2.10	8.9701	2.816	46								Do
BH156	10	11.25-12.00	2.625	2.615	0.37	1.6990	2.659				44.55					Do
BH157	15	15.00-15.75										94.67				Do

Annexure-2

CRITERIA FOR EARTHQUAKE RESISTANT DESIGN OF STRUCTURES AND EQUIPMENT

All structures and equipment shall be designed for seismic forces adopting the site specific seismic information provided in this document and using the other provisions in accordance with IS:1893 (Part 1 to Part 4). Pending finalization of Part 5 of IS:1893, provisions of part 1 shall be read along with the relevant clauses of IS:1893:1984, for embankments.

A site specific seismic study has been conducted for the project site. The peak ground horizontal acceleration for the project site, the site specific acceleration spectral coefficients (in units of gravity acceleration 'g') in the horizontal direction for the various damping values and the multiplying factor (to be used over the spectral coefficients) for evaluating the design acceleration spectra are as given at Appendix-I.

Vertical acceleration spectral values shall be taken as 2/3rd of the corresponding horizontal values.

The site specific design acceleration spectra shall be used in place of the response acceleration spectra, given at figure-2 in IS:1893 (Part 1) and Annex B of IS:1893 (Part 4). The site specific acceleration spectra along with multiplying factors specified in Appendix-I includes the effect of the seismic environment of the site, the importance factor related to the structures and the response reduction factor. Hence, the design spectra do not require any further consideration of the zone factor (Z), the importance factor (I) and response reduction factor (R) as used in the IS:1893 (Part 1 to Part 4).

Damping in Structures

The damping factor (as a percentage of critical damping) to be adopted shall not be more than as indicated below for:

a)	Steel structures	:	2%
b)	Reinforced Concrete structures	:	5%
c)	Reinforced Concrete Stacks	:	3%
d)	Steel stacks	:	2%

Method of Analysis

Since most structures in a power plant are irregular in shape and have irregular distribution of mass and stiffness, dynamic analysis for obtaining the design seismic forces shall be carried out using the response spectrum method. The number of vibration modes used in the analysis should be such that the sum total of modal masses of all modes considered is at least 90 percent of the total seismic mass and shall also meet requirements of IS:1893 (Part 1). Modal combination of the peak response quantities shall be performed as per Complete Quadratic Combination (CQC) method or by an acceptable alternative as per IS:1893 (Part 1).

In general, seismic analysis shall be performed for the three orthogonal (two principal horizontal and one vertical) components of earthquake motion. The seismic response from the three components shall be combined as specified in IS:1893 (Part 1).

The spectral acceleration coefficient shall get restricted to the peak spectral value if the fundamental natural period of the structure falls to the left of the peak in the spectral acceleration curve.

For buildings, if the design base shear (V_B) obtained from modal combination is less than the base shear ($\bar{V}_B$) computed using the approximate fundamental period (T_a) given in IS:1893:Part 1 and using site specific acceleration spectra with appropriate multiplying factor, the response quantities (e.g. member forces, displacements, storey forces, storey shears and base reactions) shall be enhanced in the ratio of $\bar{V}_B / V_B$. However, no reduction is permitted if $\bar{V}_B$ is less than V_B.

For regular buildings less than 12m in height, design seismic base shear and its distribution to different floor levels along the height of the building may be carried out as specified under clause 7.5, 7.6 & 7.7 of IS:1893 (Part 1) and using site specific design acceleration spectra. The design horizontal acceleration spectrum value (Ah) shall be computed for the fundamental natural period as per clause 7.6 of IS:1893 (Part 1) using site specific spectral acceleration coefficients with appropriate multiplying factor given in Appendix-I.

Design/Detailing for Ductility for Structures

The site specific design acceleration spectra is a reduced spectra and has an in-built allowance for ductility. Structures shall be engineered and detailed in accordance with relevant Indian/International standards to achieve ductility.

SITE SPECIFIC SEISMIC PARAMETERS FOR DESIGN OF STRUCTURES AND EQUIPMENT

The various site specific seismic parameters for the project site shall be as follows:

1)	Peak ground horizontal acceleration (MCE)	: 0.41 g
2)	Multiplying factor to be applied to the site specific horizontal acceleration spectral coefficients (in units of gravity acceleration 'g') to obtain the design acceleration spectra	
a)	for ordinary moment resisting steel frames designed and detailed as per IS:800	: 0.103
b)	for braced steel frames designed and detailed as per IS:800	: 0.077
c)	For special moment resisting RC frames designed and detailed as per IS:456 and IS:13920	: 0.062
d)	for RCC chimney	: 0.205
e)	for liquid retaining tanks	: 0.123
f)	for steel chimney	: 0.154
g)	for design of structures not covered under 2 (a) to 2 (f) above and under 3 below	: 0.103
3)	Multiplying factor to be applied to the site specific horizontal acceleration spectral coefficients (in units of gravity acceleration 'g') for design of equipment and structures where inelastic action is not relevant or not permitted	: 0.205

Notes:
1. g = Acceleration due to gravity
2. For industrial structures, analysis for verification of mechanism shall be carried out as per IS:1893 (Part 4):2015

The horizontal seismic acceleration spectral coefficients are furnished in subsequent pages.

HORIZONTAL SEISMIC ACCELERATION SPECTRAL COEFFICIENTS
(In units of 'g')

Time Period (Sec)	Damping Factor (as a percentage of critical damping)		
	2%	3%	5%
0	1.000	1.000	1.000
0.03	1.000	1.000	1.000
0.04	1.555	1.405	1.293
0.05	2.190	1.828	1.578
0.06	2.898	2.267	1.857
0.07	3.670	2.720	2.131
0.075	3.670	3.175	2.267
0.08	3.670	3.175	2.500
0.083	3.670	3.175	2.500
0.085	3.670	3.175	2.500
0.09	3.670	3.175	2.500
0.1	3.670	3.175	2.500
0.105	3.670	3.175	2.500
0.11	3.670	3.175	2.500
0.115	3.670	3.175	2.500
0.12	3.670	3.175	2.500
0.125	3.670	3.175	2.500
0.13	3.670	3.175	2.500
0.135	3.670	3.175	2.500
0.14	3.670	3.175	2.500
0.145	3.670	3.175	2.500
0.15	3.670	3.175	2.500
0.2	3.670	3.175	2.500
0.22	3.670	3.175	2.500
0.23	3.670	3.175	2.500
0.24	3.670	3.175	2.500
0.3	3.670	3.175	2.500
0.35	3.670	3.175	2.500
0.4	3.670	3.175	2.500
0.45	3.111	2.822	2.222
0.5	2.800	2.540	2.000
0.55	2.545	2.309	1.818
0.6	2.333	2.117	1.667
0.65	2.154	1.954	1.538
0.7	2.000	1.814	1.429
0.75	1.867	1.693	1.333
0.8	1.750	1.588	1.250
0.85	1.647	1.494	1.176
0.9	1.556	1.411	1.111
0.95	1.474	1.337	1.053
1	1.400	1.270	1.000

HORIZONTAL SEISMIC ACCELERATION SPECTRAL COEFFICIENTS
(In units of 'g')

Time Period (Sec)	Damping Factor (as a percentage of critical damping)		
	2%	3%	5%
1.05	1.333	1.210	0.952
1.1	1.273	1.155	0.909
1.15	1.217	1.104	0.870
1.2	1.167	1.058	0.833
1.25	1.120	1.016	0.800
1.3	1.077	0.977	0.769
1.35	1.037	0.941	0.741
1.4	1.000	0.907	0.714
1.45	0.966	0.876	0.690
1.5	0.933	0.847	0.667
1.55	0.903	0.819	0.645
1.6	0.875	0.794	0.625
1.65	0.848	0.770	0.606
1.7	0.824	0.747	0.588
1.75	0.800	0.726	0.571
1.8	0.778	0.706	0.556
1.85	0.757	0.686	0.541
1.9	0.737	0.668	0.526
1.95	0.718	0.651	0.513
2	0.700	0.635	0.500
2.05	0.683	0.620	0.488
2.1	0.667	0.605	0.476
2.15	0.651	0.591	0.465
2.2	0.636	0.577	0.455
2.25	0.622	0.564	0.444
2.3	0.609	0.552	0.435
2.35	0.596	0.540	0.426
2.4	0.583	0.529	0.417
2.45	0.571	0.518	0.408
2.5	0.560	0.508	0.400
2.55	0.549	0.498	0.392
2.6	0.538	0.488	0.385
2.65	0.528	0.479	0.377
2.7	0.519	0.470	0.370
2.8	0.500	0.454	0.357
2.85	0.491	0.446	0.351
2.9	0.483	0.438	0.345
2.95	0.475	0.431	0.339
3	0.467	0.423	0.333
3.05	0.459	0.416	0.328
3.1	0.452	0.410	0.323
3.15	0.444	0.403	0.317

HORIZONTAL SEISMIC ACCELERATION SPECTRAL COEFFICIENTS
(In units of 'g')

Time Period (Sec)	Damping Factor (as a percentage of critical damping)		
	2%	3%	5%
3.2	0.438	0.397	0.313
3.25	0.431	0.391	0.308
3.3	0.424	0.385	0.303
3.35	0.418	0.379	0.299
3.4	0.412	0.374	0.294
3.45	0.406	0.368	0.290
3.5	0.400	0.363	0.286

SECTION-D
(GENERAL TECHNICAL REQUIRMENT)

GENERAL TECHNICAL REQUIREMENT FOR THE PROJECT/PACKAGE

GENERAL TECHNICAL REQUIREMENTS

PART - C

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1.00.00 **INTRODUCTION**

This part covers technical requirements which will form an integral part of the Contract. The following provisions shall supplement all the detailed technical specifications and requirements brought out in Section-VI, the Technical Specification and the Technical Data Sheets.

2.00.00 **BRAND NAME**

Whenever a material or article is specified or described by the name of a particular brand, manufacturer or vendor, the specific item mentioned shall be understood to be indicative of the function and quality desired, and not restrictive; other manufacturer's products may be considered provided sufficient information is furnished to enable the Employer to determine that the products proposed are equivalent to those named.

3.00.00 **BASE OFFER & ALTERNATE PROPOSALS**

The Bidder's proposal shall be based upon the use of equipment and material complying fully with the requirements specified herein. It is recognized that the Contractor may have standardized on the use of certain components, materials, processes or procedures different than those specified herein. Alternate proposals offering similar equipment based on the manufacturer's standard practice will also be considered, provided the base offer is in line with technical specifications and such proposals meet the specified design standards and performance requirement and are acceptable to the Employer. Sufficient amount of information for justifying such proposals shall be furnished to Employer alongwith the bid to enable the Employer to determine the acceptability of these proposals.

4.00.00 **COMPLETENESS OF FACILITIES**

4.01.00 Bidders may note that this is a turnkey contract. Each of the plant shall be engineered and designed in accordance with the specification requirement. All engineering and associated services are required to ensure a completely engineered plant shall be provided.

4.02.00 All equipments furnished by the Contractor shall be complete in every respect, with all mountings, fittings, fixtures and standard accessories normally provided with such equipment and/or those needed for erection, completion and safe operation of the equipment and for the safety of the operating personnel, as required by applicable codes, though they may not have been specifically detailed in the respective specifications, unless included in the list of exclusions.

All same standard components/ parts of same equipment provided, shall be interchangeable with one another.

4.03.00 For the C&I systems, the Contractor shall be required to provide regular information about future upgrades and migration paths to the Employer.

5.00.00 **CODES & STANDARDS**

5.01.00 In addition to the codes and standards specifically mentioned in the relevant technical specifications for the equipment / plant / system, all equipment parts, systems and works covered under this specification shall comply with all currently applicable statutory regulations and safety codes of the Republic of India as well as of the locality where they will be installed, including the following :

a) Indian Electricity Act

b) Indian Electricity Rules

c) Indian Explosives Act

d) Indian Factories Act and State Factories Act

e) Indian Boiler Regulations (IBR)

f) Regulations of the Central Pollution Control Board, India

g) Regulations of the Ministry of Environment & Forest (MoEF), Government of India

h) Pollution Control Regulations of Department of Environment, Government of India

i) State Pollution Control Board.

(j.) Rules for Electrical installation by Tariff Advisory Committee (TAC).

(k.) Building and other construction workers (Regulation of Employment and Conditions of services) Act, 1996

(l.) Building and other construction workers (Regulation of Employment and Conditions of services) Central Rules, 1998

(m.) Explosive Rules, 1983

(n.) Petroleum Act, 1984

(o.) Petroleum Rules, 1976,

(p.) Gas Cylinder Rules, 1981

	(q.) Static and Mobile Pressure Vessels (Unified) Rules, 1981
	(r.) Workmen's Compensation Act, 1923
	(s.) Workmen's Compensation Rules, 1924
	(t.) NTPC Safety Rules for Construction and Erection
	(u.) NTPC Safety Policy
	(v.) Any other statutory codes / standards / regulations, as may be applicable.
5.02.00	Unless covered otherwise in the specifications, the latest editions (as applicable as on date of bid opening), of the codes and standards given below shall also apply :
	a) Bureau of Indian standards (BIS)
	b) Japanese Industrial Standards (JIS)
	c) American National Standards Institute (ANSI)
	d) American Society of Testing and Materials (ASTM)
	e) American Society of Mechanical Engineers (ASME)
	f) American Petroleum Institute (API)
	g) Standards of the Hydraulic Institute , U.S.A.
	h) International Organization for Standardization (ISO)
	i) Tubular Exchanger Manufacturer's Association (TEMA)
	j) American Welding Society (AWS)
	k) National Electrical Manufacturers Association (NEMA)
	l) National Fire Protection Association (NFPA)
	m) International Electro-Technical Commission (IEC)
	n) Expansion Joint Manufacturers Association (EJMA)
	o) Heat Exchange Institute (HEI)
	p) IEEE standard

	q) JEC standard
5.03.00	Other International/ National standards such as DIN, VDI, BS, GOST etc. shall also be accepted for only material codes and manufacturing standards, subject to the Employer's approval, for which the Bidder shall furnish, adequate information to justify that these standards are equivalent or superior to the standards mentioned above. In all such cases the Bidder shall furnish specifically the variations and deviations from the standards mentioned elsewhere in the specification together with the complete word to word translation of the standard that is normally not published in English.
5.04.00	As regards highly standardised equipments such as Steam Turbine and Generator, National /International standards such as JIS, DIN, VDI, ISO, SEL, SEW, VDE, IEC & VGB shall also be considered as far as applicable for Design, Manufacturing and Testing of the respective equipment. However, for those of the above equipment not covered by these National / International standards, established and proven standards of manufacturers shall also be considered.
5.05.00	In the event of any conflict between the codes and standards referred to in the above clauses and the requirement of this specification, the requirement of Technical Specification shall govern.
5.06.00	Two (2) English language copies of all national and international codes and/or standards used in the design of the plant and equipment shall be provided by the Contractor to the Employer within two calendar months from the date of the Notification of Award.
5.07.00	In case of any change in codes, standards & regulations between the date of bid opening and the date when vendors proceed with fabrication, the Employer shall have the option to incorporate the changed requirements or to retain the original standard. It shall be the responsibility of the Contractor to bring to the notice of the Employer such changes and advise Employer of the resulting effect.
5.08.00	A detailed list of standards apart from those mentioned in the respective detailed specifications in other parts of Section-VI to which all equipment/systems/civil works should conform as indicated in this Part C and elsewhere in the specification.
6.00.00	**EQUIPMENT FUNCTIONAL GUARANTEE**
6.01.00	The functional guarantees of the equipment under the scope of the Contract is given in Section-VI Part - A & B of Technical Specifications. These guarantees shall supplement the general functional guarantee provisions covered under Defect liabilities Section-IV, General Conditions of Contract.

6.02.00 Liquidated damages for shortfall in meeting functional guarantee(s) during the performance and guarantee tests shall be assessed and recovered from the Contractor as specified elsewhere in this specification.

7.00.00 **DESIGN OF FACILITIES/ MAINTENANCE & AVAILABILITY CONSIDERATIONS**

7.01.00 **DESIGN OF FACILITIES**

All the design procedures, systems and components proposed shall have already been adequately developed and shall have demonstrated good reliability under similar conditions elsewhere.

The Contractor shall be responsible for the selection and design of appropriate equipments to provide the best coordinated performance of the entire system. The basic requirements are detailed out in various clauses of the Technical Specifications. The design of various components, assemblies and subassemblies shall be done so that it facilitates easy field assembly and dismantling. All the rotating components shall be so selected that the natural frequency of the complete unit is not critical or close to the operating range of the unit.

7.02.00 **MAINTENANCE AND AVILABILITY CONSIDERATIONS**

Equipment/works offered shall be designed for high availability, low maintenance and ease of maintenance. The Bidder shall specifically state the design features incorporated to achieve high degree of reliability/ availability and ease of maintenance. The Bidder shall also furnish details of availability records in the reference plants stated in his experience list.

Bidder shall state in his offer the various maintenance intervals, spare parts and man-hour requirement during such operation. The intervals for each type of maintenance namely inspection of the furnace, inspection of the entire hot gas path and the minor and major overhauls shall be specified in terms of fired hours , clearly defining the spare parts and man-hour requirement for each stage.

Lifting devices i.e. hoists and chain pulley jacks ,etc. shall be provided by the contractor for handling of any equipment or any of its part having weight in excess of 500 Kgs during erection and maintenance activities.

Lifting devices like lifting tackles, slings, etc. to be connected to hook of the hoist / crane shall be provided by the contractor for lifting the equipment and accessories covered under the specification.

8.00.00 **DOCUMENTS, DATA AND DRAWINGS TO BE FURNISHED BY CONTRACTOR**

8.01.00 Bidders may note that this is a turnkey contract. Each of the plant and equipment shall be fully integrated, engineered and designed to perform in accordance with the technical specification. All engineering and technical services required to ensure a completely engineered plant shall be provided in respect of mechanical, electrical and power systems, control & instrumentation, civil & structural works.

The Contractor shall furnish engineering data /drawings in accordance with the schedule of information as specified in Technical Data Sheets and Technical Specification.

A comprehensive engg and quality coordination procedure shall be finalized with the successful bidder covering salient features as described in this section of specifications.

8.02.00 The number of copies/prints/CD-ROMs/manuals to be furnished for various types of document is given in **Annexure-VI** to this Part-C, Section-VI of the Technical Specification.

8.03.00 The documentation that shall be provided by the Contractor is indicated in the various sections of specification. This documentation shall include but not be limited to the following:

8.03.01 A) **BASIC ENGINEERING DOCUMENTATION**

Prior to commencement of the detailed engineering work, the Contractor shall furnish a Plant Definition Manual within 12 weeks from the date of the Notification of Award. This manual shall contain the following as a minimum:

i) System description of all the mechanical, electrical, control & instrumentation & civil systems.

ii) Technology scan for each system / sub-system & equipment.

iii) Selection of appropriate technology / schemes for various systems/ subsystems including techno-economic studies between various options.

iv) Optimisation studies including thermal cycle optimisation.

v) Sizing criteria of all the systems, sub-systems/ equipments/ structures/ equipment foundations alongwith all calculations justifying and identifying the sizing and the design margins.

vi) Schemes and Process & Instrumentation diagrams for the various systems/ sub-system with functional write-ups.

vii) Water Balance diagram.

viii) Operation Philosophy and the control philosophy of the Main Plant and other plants.

ix) General Layout plan of the power station incorporating all facilities in Bidder's as well as those in the Employer's scope. This drawing shall also be furnished in the form of CD-ROMs to the Employer for engineering of areas not included in bidder's scope.

x) Basic layouts and cross sections of the main plant building (various floor elevations), boiler, fuel oil area, transformer yard, switchyard and other areas included in the scope of the bidder.

xi) Documentation in respect of Quality Assurance System as listed out elsewhere in this specification.

The successful bidder shall furnish within three (3) weeks from the date of Notification of Award, a list of contents of the Plant Definition Manual (PDMs) including techno-economic studies, which shall then be mutually discussed & finalised with the Employer.

B) **DETAILED ENGINEERING DOCUMENTS**

i) General layout plan of the station.

ii) Layouts, general arrangements, elevations and cross-sections drawings for all the equipment and facilities of the plant.

iii) Flow diagram, process and instrumentation diagrams along with write up and system description.

iv) Start up curves for boiler and both turbines and boiler combined together as a unit for various start ups, viz. cold, warm and hot start up.

v) Piping isometric, composite layout and fabrication drawings.

vi) Piping engineering diagrams, pipe and fittings schedules, valve schedules, hanger and support schedules, insulation schedules.

vii) Technical data sheets for all bought out and manufactured items. Contractor shall use the Employer's specifications as a base for placement of orders on their sub vendors.

viii) Detailed design calculations for components, system, piping etc., wherever applicable including sizing calculations for all auxiliaries like mills, fans, BFPs, CEPs, Heaters/ Deaerators, Condensers, vacuum pumps etc.

ix) Boiler pressure part schedule and sizing calculations. Boiler performance data and boiler design dossier.

x) Transient, hydraulic and thermal stress analysis of piping and system wherever applicable & input and output data alongwith stress analysis isometrics showing nodes..

xi) Thermal cycle information (heat balance diagrams, boiler performance calculations, condenser and heat exchanger thermal calculations etc.).

xii) Characteristic Curves/ Performance Correction Curves. Hydraulic & Mechanical design calculations for condensers & heaters.

xiii) Comprehensive list of all terminal points which interface with Employer's facilities, giving details of location, terminal pressure, temperature, fluid handled & end connection details, forces, moments etc.

xiv) Power supply single line diagram, block logics, control schematics, electrical schematics, etc.

xv) Protection system diagrams and relay settings.

xvi) Cables schedules and interconnection diagrams.

xvii) Cable routing plan.

xviii) Instrument schedule, measuring point list, I/O list, Interconnection & wiring diagram, functional write-ups, installation drawings for field mounted instruments, logic diagrams, control schematics, wiring and tubing diagrams of panels and enclosures etc. Drawings for open loop and close loop controls (both hardware and software). Motor list and valve schedule including type of actuator etc.

xix) Alarm and annunciation/ Sequence of Event (SOE) list and alarms & trip set points.

xx) Sequence and protection interlock schemes.

xxi) Type test reports, insulation co-ordination study report and power system stability study report.

xxii) Control system configuration diagrams and card circuit diagrams and maintenance details.

xxiii) Detailed DDCMIS system manuals.

xxiv) Detailed flow chart for digital control system.

xv) Mimic diagram layout, Assignment for other application engg.

xxvi) Civil and Structural works drawings and documents for all structures, facilities, architectural works, foundations underground and overground works and super-structural works as included in the scope of the bidder civil calculation sheets including structural analysis and design alongwith output results.

xxvii) Underground facilities, levelling ,sanitary, land scaping drawings.

xxviii) Geotechnical investigation and site survey reports (if and as applicable).

xxix) Model study reports wherever applicable.

xxx) Functional & guarantee test procedures and test reports.

xxxi) Documentation in respect of Quality Assurance System, and Documentation in respect of Commissioning, as listed out elsewhere in this specification.

The Contractor's while sumitting the above documents/ drawings for approval/ reference as the case may be, shall mark on each copy of submission the reference letter alongwith the date vide which the submissions are made.

8.03.02 **INSTRUCTION MANUALS**

The Contractor shall submit to the Employer, draft Instruction Manuals for all the equipments covered under the Contract by the end of one year from the date of his acceptance of the Letter of Award. The Instruction manuals shall contain full details required for erection, commissioning, operation and maintenance of each equipment. The manual shall be specifically compiled for this project. After finalisation and approval of the Employer the Instruction Manuals shall be submitted as indicated in **Annexure-IV.** The Contract shall not be considered to be completed

for purposes of taking over until the final Instructions manuals have been supplied to the Employer. The Instruction Manuals shall comprise of the following.

A) ERECTION MANUALS

The erection manuals shall be submitted atleast three (3) months prior to the commencement of erection activities of particular equipment/system. The erection manual should contain the following as a minimum.

a) Erection strategy.

b) Sequence of erection.

c) Erection instructions.

d) Critical checks and permissible deviation/tolerances.

e) List of tool, tackles, heavy equipments like cranes, dozers, etc.

f) Bill of Materials

g) Procedure for erection and General Safety procedures to followed during erection/installation.

h) Procedure for initial checking after erection.

i) Procedure for testing and acceptance norms.

j) Procedure / Check list for pre-commissioning activities.

k) Procedure / Check list for commissioning of the system.

l) Safety precautions to be followed in electrical supply distribution during erection.

B) OPERATION & MAINTENANCE MANUALS

a) The manual shall be a two rim PVC bound stiff sided binder able to withstand constant usage or where a thicker type is required it shall have locking steel pins, the size of the manual shall not be larger than international size A3. The cover shall be printed with the Project Name, Services covered and Volume / Book number Each section of the manual shall be divided by a stiff divider of the same size as the holder. The dividers shall clearly state the section number and title. All written instructions within the manual not provided by the

manufacturers shall be typewritten with a margin on the left hand side.

b) The arrangement and contents of O & M manuals shall be as follows :

1) Chapter 1 - Plant Description : To contain the following sections specific to the equipment/system supplied

(a) Description of operating principle of equipment / system with schematic drawing / layouts.

(b) Functional description of associated accessories / controls. Control interlock protection write up.

(c) Integrated operation of the equipment alongwith the intended system. (The is to be given by the supplier of the Main equipment by taking into account the operating instruction given by the associated suppliers).

(d) Exploded view of the main equipment, associated accessories and auxiliaries with description. Schematic drawing of the equipment alongwith its accessories and auxiliaries.

(e) Design data against which the plant performance will be compared.

(f) Master list of equipments, Technical specification of the equipment/ system and approved data sheets.

(g) Identification system adopted for the various components, (it will be of a simple process linked tagging system).

(h) Master list of drawings (as built drawing - Drawings to be enclosed in a separate volume).

2) Chapter 2.0 - Plant Operation: To contain the following sections specific to the equipment supplied

(a) Protection logics provided for the equipment alongwith brief philosophy behind the logic, Drawings etc.

(b) Limiting values of all protection settings.

(c) Various settings of annunciation/interlocks provided.

(d) Startup and shut down procedure for equipment alongwith the associated systems in step mode.

(e) Do's and Don'ts related to operation of the equipment.

(f) Safety precautions to be take during normal operation. Emergency instruction on total power failure condition/lubrication failure/any other conditions.

(g) Parameters to be monitored with normal value and limiting values.

(h) Equipment isolating procedures.

(i) Trouble shooting with causes and remedial measures.

(j) Routine testing procedure to ascertain healthiness of the safety devices alongwith schedule of testing.

(k) Routine Operational Checks, Recommended Logs and Records

(l) Change over schedule if more than one auxiliary for the same purpose is given.

(m) Preservation procedure on long shut down.

(n) System/plant commissioning procedure.

3) Chapter 3.0 - Plant Maintenance- To contain the following sections specific to the equipment supplied.

(a) Exploded view of each of the equipments. Drawings alongwith bill of materials including name, code no. & population.

(b) Exploded view of the spare parts and critical components with dimensional drawings (In case of Electronic cards, the circuit diagram to be given) and spare parts catalogue for each equipment.

(c) List of Special T/ P required for Overhauling /Trouble shooting including special testing equipment required for calibration etc.

(d) Stepwise dismantling and assembly procedure clearly specifying the tools to be used, checks to be made, records to be maintained etc. Clearance to be maintained etc.

(e) Preventive Maintenance schedules linked with running hours/calendar period alongwith checks to be carried out.

(f) Overhauling schedules linked with running hours/calendar period alongwith checks to be done.

(g) Long term maintenance schedules

(h) Consumables list alongwith the estimated quantity required during normal running and during maintenance like Preventive Maintenance and Overhauling.

(i) List of lubricants with their Indian equivalent, Lubrication Schedule including charts showing lubrication checking, testing and replacement procedure to be carried daily, weekly, monthly & at longer intervals to ensure trouble free operation and quantity required for complete replacement..

(j) Tolerance for fitment of various components.

(k) Details of sub vendors with their part no. in case of bought out items.

(l) List of spare parts with their Part No, total population, life expediency & their interchangeability with already supplied spares to NTPC.

(m) List of mandatory and recommended spare list along with manufacturing drawings, material specification & quality plan for fast moving consumable spares.

(n) Lead time required for ordering of spares from the equipment supplier, instructions for storage and preservation of spares.

(o) General information on the equipment such as modification carried out in the equipment from its inception, equipment population in the country / foreign country and list of utilities where similar equipments have been supplied.

8.03.03 After finalization and approval of the Employer, the O & M Manuals shall be submitted as indicated in Annexure-VI. The Contract shall not be considered to be completed for purposes of taking over until the final Instructions manuals (both erection and O & M manuals have been supplied to the Employer.

If after the commissioning and initial operation of the plant, the instruction manuals (Erection and /or O &M manuals) require modifications/additions/ changes, the same shall be incorporated and the updated final instruction manuals shall be submitted by

the Contractor to the Employer for records and number of copies shall be as mentioned in Annexure-VI.

8.03.03 **PLANT HANDBOOK AND PROJECT COMPLETION REPORT**

8.03.03.01 **PLANT HANDBOOK**

The Contractor shall submit to the Employer a preliminary plant hand book preferably in A-4 size sheets which shall contain the design and performance data of various plants, equipments and systems covering the complete project including

i) Design and performance data.

ii) Process & Instrumentation diagrams.

iii) Single line diagrams.

iv) Sequence & Protection Interlock Schemes.

v) Alarm and trip values.

vi) Performance Curves.

vii) General layout plan and layout of main plant building and auxiliary buildings

viii) Important Do's & Don't's

The plant handbook shall be submitted within twelve (12) months from the date of award of contract. After the incorporation of Employer's comments, the final plant handbook complete in all respects shall be submitted three (3) months before start-up and commissioning activities.

8.03.03.02 **PROJECT COMPLETION REPORT**

The Contractor shall submit a Project Completion Report at the time of handing over the plant.

8.03.04 **DRAWINGS**

a) i) All the plant layouts shall be made in computerised 3D modelling system. The Employer reserves the right to review the 3D model at different stages during the progress of engineering.The layout drawings submitted for Employer's review shall be fully dimensioned and extracted from 3D model after interference check.

ii) All documents submitted by the Contractor for Employer's review shall be in electronic form (soft copies) along with the desired number of hard copies as per **Annexure-VI** of Part-C.The soft copies shall be uploaded by the vendors in C-folders, a Web-based system of NTPC ERP, for which a username and password will be allotted to the new vendor by NTPC.

Similarly, the vendor can download the drawings/documents, approved/ commented by NTPC, through above site.

The soft copies of identified drawings/documents shall be in pdf format, whereas the attachments/reply to the submitted document(s) can be in .doc, .xls, .pdf, .dwg or .std formats.

iii) Final copies of the approved drawings along with requisite number of hard copies shall be submitted as per **Annexure-VI** of Part-C.

iv) Contractor shall prepare the model of all the facilities located in Main Power Block area, covering Transformer Yard, TG building (including all facilities), Boiler area, ESP area, chimney area and any other facility located in Main Plant Block area in an integrated & intelligent 3D software solution using rule based, data centric 3D design software with equipment drawings, data sheets, intelligent P&ID correlated with intelligent 3D Model, BOQ, schematics and logic diagrams etc. attached to the respective equipment / systems in the aforesaid 3D model.

All piping layouts, equipment layouts, floor plans, ducting layout (Air/flue gas, A/C, Ventilation etc.), General Arrangement drawings of major buildings, structural arrangement drawings and RCC layout drawings shall necessarily be extracted from the aforesaid 3D model and submitted for employer's review along with the 3D review model to enable NTPC to review and approve these drawings.

Contractor shall prepare and provide 3D design review model (network ready, which shall include visual interference check, walk-through animation, video simulation for major equipment placement and removal, visual effect, photo realism etc.), which is extracted from intelligent 3D model and shall make a presentation of the same every 3 months from LOA to enable NTPC to review the progress of engineering or as & when required by employer.

After the completion of engineering of respective area i.e. TG building/ Boiler/ ESP etc., the corresponding complete 3D review model shall be handed over to the employer for its reference.

b) All documents/text information shall be in latest version of MS Office/MS Excel/PDF format as applicable.

c) All drawings submitted by the Contractor including those submitted at the time of bid shall be in sufficient detail indicating the type, size, arrangement, weight of each component for packing and shipment, the external connection, fixing arrangement required, the dimensions required for installation and interconnections with other equipments and materials, clearance and spaces required between various portions of equipment and any other information specifically requested in the drawing schedules.

d) Each drawing submitted by the Contractor (including those of subvendors) shall bear a title block at the right hand bottom corner with clear mention of the name of the Employer, the system designation, the specifications title, the specification number, the name of the Project, drawing number and revisions. If standard catalogue pages are submitted the applicable items shall be indicated therein. All titles, notings, markings and writings on the drawing shall be in English. All the dimensions should be in metric units.

e) The drawings submitted by the Contractor (or their subvendors) shall bear Employer's drawing number in addition to contractor's (their sub-vendor's) own drawing number. Employer's drawing numbering system shall be made available to the successful bidder so as to enable him to assign Employer's drawing numbers to the drawings to be submitted by him during the course of execution of the Contract.

The Contractor shall also furnish a "Master Drawing List" which shall be a comprehensive list of all drawings/ documents/ calculations envisaged to be furnished by him during the detailed engineering to the Employer. Such list should clearly indicate the purpose of submission of these drawings i.e. "FOR APPROVAL" or "FOR INFORMATION ONLY".

Similarly, all the drawings/ documents submitted by the Contractor during detailed engineering stage shall be marked "FOR APPROVAL" or "FOR INFORMATION" prior to submission. Further, space shall be identified on each drawing for Approval stamp and electronic signature.

f) The furnishing of detailed engineering data and drawings by the Contractor shall be in accordance with the time schedule for the project . The review of these documents/ data/ drawings by the Employer will cover only general conformance of the data/ drawings/ documents to the specifications and contract, interfaces with the equipments provided by others and external connections & dimensions which might affect plant layout. The review by the Employer should not be construed to be a thorough review of all dimensions, quantities and details of the equipments, materials, any devices or items indicated or the accuracy of the information submitted. The review and/ or

approval by the Employer/ Project Manager shall not relieve the Contractor of any of his responsibilities and liabilities under this contract.

g) After the approval of the drawings, further work by the Contractor shall be in strict accordance with these approved drawings and no deviation shall be permitted without the written approval of the Employer.

h) All manufacturing, fabrication and execution of work in connection with the equipment / system, prior to the approval of the drawings, shall be at the Contractor's risk. The Contractor is expected not to make any changes in the design of the equipment /system, once they are approved by the Employer. However, if some changes are necessitated in the design of the equipment/system at a later date, the Contractor may do so, but such changes shall promptly be brought to the notice of the Employer indicating the reasons for the change and get the revised drawing approved again in strict conformance to the provisions of the Technical Specification.

i) Drawings shall include all installations and detailed piping layout drawings. Layout drawings for all piping of 65 mm and larger diameter shall be submitted for review/ approval of Employer piror to erection. Small diameter pipes shall however be routed as per site conditions in consultation with site authority/ representative of Employer based on requirements of such piping indicated in approved/ finalised Flow Scheme/ Process & Instrumentation Diagrams and/or the requirements cropping up for draining & venting of larger diameter piping or otherwise after their erection as per actual physical condition for the entire scope of work of this turnkey package.

Assessing & anticipating the requirement and supply of all piping and equipment shall be done by the contractor well in advance so as not to hinder the progress of piping & equipment erection, subsequent system charging and its effective draining & venting arrangement as per site suitability.

j) As Built Drawings

After final acceptance of individual equipment / system by the Employer, the Contractor will update all original drawings and documents for the equipment / system to “as built” conditions and submit no. of copies as per **Annexure VI**.

k) Drawings must be checked by the Contractor in terms of its completeness, data adequacy and relevance with respect to Engineering schedule prior to submission to the Employer. In case drawings are found to be submitted without proper checking by the Contractor, the same shall not be reviewed and returned to the Contractor for re-submission. The contractor shall make a visit to site to see the existing facilities and understand the layout

completely and collect all necessary data/ drawings at site which are needed as an input to the engineering. The contractor shall do the complete engineering including interfacing and integration of all his equipment, systems & facilities within his scope of work as well as interface engineering & integration of systems, facilities, equipment & works under Employer's scope and submit all necessary drawings/ documents for the same.

l) The Contractor shall submit adequate prints of drawing / data / document for Employer's review and approval. The Employer shall review the drawings and return soft copy to the Contractor authorizing either to proceed with manufacture or fabrication, or marked to show changes desired. When changes are required, drawings shall be re-submitted promptly, with revisions clearly marked, for final review. Any delays arising out of the failure of the Contractor to submit/rectify and resubmit in time shall not be accepted as a reason for delay in the contract schedule.

m) All engineering data submitted by the Contractor after final process including review and approval by the Project Manager/ Employer shall form part of the contract documents and the entire works covered under these specification shall be performed in strict conformity with technical specifications unless otherwise expressly requested by the Project Manager in writing.

8.04.00 **ENGINEERING INFORMATION SUBMISSION SCHEDULE**

Prior to the award of Contract, a Detailed Engineering Information Submission Schedule shall be tied up with the Employer. For this, the bidder shall furnish a detailed list of engineering information alongwith the proposed submission schedule. This list would be a comprehensive one including all engineering data / drawings / information for all bought out items and manufactured items. The information shall be categorised into the following parts.

i) Information that shall be submitted for the approval to the Employer before proceeding further, and

ii) Information that would be submitted for Employer's information only.

The Master Drawing List(MDL) shall be updated periodically and submitted to the employer, highlighting the changes made in MDL.

The schedule should allow adequate time for proper review and incorporation of changes/ modifications, if any, to meet the contract without affecting the equipment delivery schedule and overall project schedule. The early submission of drawings and data is as important as the manufacture and delivery of equipment and hardware and this shall be duly considered while determining the overall performance and progress.

8.05.00 **Engineering Co-ordination Procedure**

8.05.01 The following principal coordinators will be identified by respective organizations at time of award of contract :

NTPC Engineering Coordinator (NTPC EC) :

Name :

Designation :

Address :

a) Postal :

b) Telegraphic / e-Mail :

c) FAX : TELEPHONE :

Contractor's/ Vendor's Engineering Coordinator (VENDOR EC):

Name :

Designation :

Address :

a) Postal :

b) Telegraphic / e-Mail :

c) FAX : TELEPHONE :

8.05.02 All engineering correspondence shall be in the name of above coordinators on behalf of the respective organizations.

8.05.03 Contractor's/Vendor's Drawing Submission and Approval Procedure :

a) All data/information furnished by Vendor in the form of drawings/ documents/catalogues or in any other form for NTPC's information/ interface and or review and approval are referred by the general term "drawings".

b) The 'Master drawings list' indicating titles, Drawing Number, Date of submission and approval etc. shall be finalised mutually between Contractor and Employer before the award of contract. This list shall be updated if required at suitable interval during detailed engineering.

c) All drawings (including those of subvendor's) shall bear at the right hand bottom corner the 'title plate' with all relevant information duly filled in. The Contractor shall furnish this format to his subvendor along with his purchase order for subvendor's compliance.

d) Employer and contractor shall follow their own numbering systems for the drawings. However, Employer shall intimate the contractor, NTPC drawing number on receipt of the first submission of each drawing. Vendor, thereafter, shall indicate NTPC's drawing number in subsequent Submission, in the space provided for this purpose in title plate, in addition to his own drawing number.

e) The contractor shall make a visit to site to see the existing facilities and understand the layout completely and collect all necessary data / drawings at site which are needed as an input to the engineering. The contractor shall do the complete engineering including interfacing and integration of all his equipment, systems & facilities within his scope of work as well as interface engineering & integration of systems, facilities, equipment & works under Employer's scope and submit all necessary drawings/ documents for the same.

f) **Drawings must be checked by the Contractor in terms of its completeness, data adequacy and relevance with respect to engineering schedule prior to submission to the Employer. In case drawings are found to be submitted without proper endorsement for checking by the Contractor, the same shall not be reviewed and returned to the Contractor for re-submission.**

g) The Contractor shall submit adequate prints of drawing / data / document for Employer's review and approval. The drawings submitted by the Contractor/vendor shall be reviewed by NTPC and their comments shall be forwarded within four (4) weeks of receipt of drawings. Upon review of each drawing, depending on the correctness and completeness of the drawing, the same will be categorized and approval accorded in one of the following categories :

CATEGORY- I:	Approved
CATEGORY- II	Approved, subject to incorporation of comments/ modification as noted. Resubmit revised drawing incorporating the comments.
CATEGORY –III	Not approved. Resubmit revised drawings for approval after incorporating comments/ modification as noted.
CATEGORY -IV	For information and records.

h) Contractor shall resubmit the drawings approved under Category II, III & IVR within three (3) weeks of receipt of comments on the drawings, incorporating all comments. Every revision of the drawing shall bear a revision index wherein such revisions shall be highlighted in the form of description or marked up in the drawing identifying the same with relevant revision Number enclosed in a triangle (eg. 1, 2, 3 etc). Contractor shall not make any changes in the portions of the drawing other than those commented. If changes are required to be made in the portions already approved, the Contractor shall resubmit the drawing identifying the changes for Employer's review and approval. **Drawings resubmitted shall show clearly the portions where the same are revised marking the relevant revision numbers and Employer shall review only such revised portion of documents.**

i) In case, the Contractor/ Vendor does not agree with any specific comment, he shall furnish the explanation for the same to NTPC for consideration. In all such cases the Contractor shall necessarily enclose explanations along with the revised drawing (taking care of balance comments) to avoid any delay and/or duplication in review work.

j) It is responsibility of the Contractor/ Vendor to get all the drawings approved in the Category I & IV (as the case may be) and complete engineering activities within the agreed schedule. Any delay arising out of submission and modification of drawings shall not alter the contract completion schedule.

k) If Contractor/ Vendor fails to resubmit the drawings as per the schedule, construction work at site will not be held up and work will be carried out on the basis of comments furnished on previous issues of the drawing.

l) These comments will be taken care by the contractor while submitting the revised drawing.

The contractor shall use a single transmittal for drawings. Submission. This shall include transmittal numbers and date, number of copies being sent, names of the agencies to whom copies being sent, drawing number and titles, remarks or special notes if any etc.

8.06.00 **ENGINEERING PROGRESS AND EXCEPTION REPORT**

8.06.01 The Contractor shall submit every month an Engineering progress and Exception Report giving the status of each engineering information including

a) A list of drawings/engineering information which remains unapproved for more than four (4) weeks after the date of first submission

b) Drawings which were not submitted as per agreed schedule.

8.06.02	The draft format for this report shall be furnished to the Employer within four (4) weeks of the award of the contract, which shall then be discussed and finalised with the Employer.
9.00.00	**TECHNICAL CO-ORDINATION MEETING**
9.01.00	The Contractor shall be called upon to organise and attend monthly Design/ Technical Co-ordination Meetings (TCMs) with the Employer/Employer's representatives and other Contractors of the Employer during the period of contract. The Contractor shall attend such meetings at his own cost at NEW DELHI / NOIDA or at mutually agreed venue as and when required and fully co-operate with such persons and agencies involved during the discussions.
9.02.00	The Contractor should note that Time is the essence of the contract. In order to expedite the early completion of engineering activities, the Contractor shall submit all drawings as per the agreed Engineering Information Submission Schedule.The drawings submitted by the Contractor will be reviewed by the Employer as far as practicable within three (3) weeks from the date of receipt of the drawing .The comments of the Employer shall then be discussed across the table during the above Technical Co-ordination Meeting (s) wherein best efforts shall be made by both sides to ensure the approval of the drawing.
9.02.01	The Contractor shall ensure availability of the concerned experts / consultants/ personnel who are empowered to take necessary decisions during these meetings. The Contractor shall be equipped with necessary tools and facilities so that the drawings/documents can be resubmitted after incorporating necessary changes and approved during the meeting itself.
9.02.02	Should any drawing remain unapproved for more than six (6) weeks after it's first submission ,this shall be brought out in the monthly Engineering Progress and Exception Report with reasons thereof.
9.03.0	Any delays arising out of failure by the Contractor to incorporate Employer's comments and resubmit the same during the TCM shall be considered as a default and in no case shall entitle the Contractor to alter the Contract completion date.
10.00.00	**DESIGN IMPROVEMENTS** The Employer or the Contractor may propose changes in the specification of the equipment or quality thereof and if the parties agree upon any such changes the specification shall be modified accordingly. If any such agreed upon change is such that it affects the price and schedule of completion, the parties shall agree in writing as to the extent of any changing the price and/or schedule of completion before the Contractor proceeds with the change.

Following such agreement, the provision thereof, shall be deemed to have been amended accordingly.

11.00.00 **EQUIPMENT BASES**

A cast iron or welded steel base plate shall be provided for all rotating equipment which is to be installed on a concrete base, unless otherwise specifically agreed to by the Employer. Each base plate shall support the unit and its drive assembly, shall be of a neat design with pads for anchoring the units, shall have a raised lip all around, and shall have threaded drain connections.

12.00.00 **PROTECTIVE GUARDS**

Suitable guards shall be provided for protection of personnel on all exposed rotating and/or moving machine parts. All such guards shall be designed for easy installation and removal for maintenance purpose.

13.00.00 **LUBRICANTS, SERVO FLUIDS AND CHEMICALS**

13.01.00 All the first fill and one year's topping requirement of consumables such as greases, oils, lubricants, servo fluids / control fluids, gases (excluding H2, CO2 and N2 for generator) and essential chemicals etc. which will be required to put the equipment covered under the scope of specifications into successful commissioning/initial operation and to establish completion of facilities shall be supplied by the contractor. Suitable standard lubricants as available in india are desired.Efforts should be made to limit the variety of lubricants to minimum.

Bidder scope shall also include supply of H2,CO2 and N2 as applicable for the generator till successful commissioning of generator.

Bidder shall also supply a quantity not less than 10% of the full charge of each variety of lubricants, servo fluids, gases, chemicals etc (as detailed above) used which is expected to be utilized during the first year of operation. This additional quantity shall be supplied in separate containers.

13.02.00 As far as possible lubricants marketed by the Indian Oil Corporation shall be used. The variety of lubricants shall be kept to a minimum possible.

Detailed specifications for the lubricating oil, grease, gases, servo fluids, control fluids, chemicals etc. required for the complete plant covered herein shall be furnished. On completion of erection, a complete list of bearings/ equipment giving their location and identification marks shall be furnished to the Employer alongwith lubrication requirements.

14.00.00 **LUBRICATION**

14.01.00	Equipment shall be lubricated by systems designed for continuous operation. Lubricant level indicators shall be furnished and marked to indicate proper levels under both standstill and operating conditions.
15.00.00	**MATERIAL OF CONSTRUCTION**
15.01.00	All materials used for the construction of the equipment shall be new and shall be in accordance with the requirements of this specification. Materials utilised for various components shall be those which have established themselves for use in such applications.
16.00.00	**RATING PLATES, NAME PLATES & LABELS**
16.01.00	Each main and auxiliary item of plant shall have permanently attached to it in a conspicuous position, a rating plate of non-corrosive material upon which shall be engraved manufacturer's name, equipment, type or serial number together with details of the ratings, service conditions under which the item of plant in question has been designed to operate, and such diagram plates as may be required by the Employer.
16.02.00	Each item of plant shall be provided with nameplate or label designating the service of the particular equipment. The inscriptions shall be approved by the Employer or as detailed in appropriate section of the technical specifications.
16.03.00	Such nameplates or labels shall be of white nonhygroscopic material with engraved black lettering or alternately, in the case of indoor circuit breakers, starters, etc. of transparent plastic material with suitably coloured lettering engraved on the back.
16.04.00	Items of plant such as valves, which are subject to handling, shall be provided with an engraved chromium plated nameplate or label with engraving filled with enamel. The name plates for valves shall be marked in accordance with MSS standard SP-25 and ANSI B 16.34 as a minimum.
16.05.00	Hanger/ support numbers shall be marked on all pipe supports, anchors, hangers, snubbers and restraint assemblies. Each constant and variable spring support shall also have stamped upon it the designed hot and cold load which it is intended to support.
16.06.00	Valves, steam traps and strainers shall be identified by Employer's tag number of a metal tap permanently attached to non pressure parts such as the yoke by a stainless steel wire.
16.07.00	Safety and relief valves shall be provided with the following: a) Manufacturer's identification.

b) Nominal inlet and outlet sizes in mm.

c) Set pressure in Kg/cm^2 (abs).

d) Blowdown and accumulation as percentage of set pressure.

e) Certified capacity in Kg of saturated steam per hour or in case of liquid certified capacity in litres of water per minute.

16.08.00 All such plates, instruction plates, etc. shall be bilingual with Hindi inscription first, followed by English. Alternatively, two separate plates one with Hindi and the other with English inscriptions may be provided.

16.09.00 All segregated phases of conductors or bus ducts, indoor or outdoor, shall be provided with coloured phase plates to clearly identify the phase of the system.

17.00.00 **TOOLS AND TACKLES**

The Contractor shall supply with the equipment one complete set of all special tools and tackles and other instruments required and other instruments for the erection, assembly, disassembly and proper maintenance of the plant and equipment and systems (including software). These special tools will also include special material handling equipment, jigs and fixtures for maintenance and calibration / readjustment, checking and measurement aids etc. A list of such tools and tackles shall be submitted by the Bidder alongwith the offer.

The price of each tool / tackle shall be deemed to have been included in the total bid price. These tools and tackles shall be separately packed and sent to site. The Contractor shall also ensure that these tools and tackles are not used by him during erection, commissioning and initial operation. For this period the Contractor should bring his own tools and tackles. All the tools and tackles shall be of reputed make acceptable to the Employer.

18.00.00 **WELDING**

18.01.00 If the manufacturer has special requirements relating to the welding procedures for welds at the terminals of the equipments to be per formed by others the requirements shall be submitted to the Employer in advance of commencement of erection work.

19.00.00 **COLOUR CODE FOR ALL EQUIPMENTS/ PIPINGS/ PIPE SERVICES**

19.01.00	All equipment/ piping/ pipe services are to be painted by the Contractor in accordance with Employer's standard colour coding scheme, which will be furnished to the Contractor during detailed engineering stage.
20.00.00	**PROTECTION AND PRESERVATIVE SHOP COATING**
20.01.00	**PROTECTION** All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either metallic or a nonmetallic protection device. All ends of all valves and piping and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage. All primers/paints/coatings shall take into account the hot humid, corrosive & alkaline, subsoil or over ground environment as the case may be. The requirements for painting specification shall be complied with as detailed out in Part-A & B of the Technical Specification.
20.02.00	**PRESERVATIVE SHOP COATING** All exposed metallic surfaces subject to corrosion shall be protected by shop application of suitable coatings. All surfaces which will not be easily accessible after the shop assembly, shall be treated beforehand and protected for the life of the equipment. All surfaces shall be thoroughly cleaned of all mill scales, oxides and other coatings and prepared in the shop. The surfaces that are to be finish-painted after installation or require corrosion protection until installation, shall be shop painted as per the requirements covered in the relevant part of the Technical Specification. Transformers and other electrical equipments, if included shall be shop finished with one or more coats of primer and two coats of high grade resistance enamel. The finished colors shall be as per manufacturer's standards, to be selected and specified by the Employer at a later date.
20.03.00	Shop primer for all steel surfaces which will be exposed to operating temperature below 95 degrees Celsius shall be selected by the Contractor after obtaining specific approval of the Employer regarding the quality of primer proposed to be applied. Special high temperature primer shall be used on surfaces exposed to temperature higher than 95 degrees Celsius and such primer shall also be subject to the approval of the Employer.
20.04.00	All other steel surfaces which are not to be painted shall be coated with suitable dust preventive compound subject to the approval of the Employer.
20.05.00	All piping shall be cleaned after shop assembly by shot blasting or other means approved by the Employer. Lube oil piping or carbon steel shall be pickled.

20.06.00 Painting for Civil structures and equipment/system covered under this package shall be done as specified under technical requirements on civil works in relevant part of this specifications.

21.00.00 **QUALITY ASSURANCE PROGRAMME**

21.01.00 To ensure that the equipment and services under the scope of contract whether manufactured or performed within the Contractor's works or at his sub-contractor's premises or at the Employer's site or at any other place of work are in accordance with the specifications, the Contractor shall adopt suitable quality assurance programme to control such activities at all points, as necessary. Such programmes shall be outlined by the Contractor and shall be finally accepted by the Employer/authorised representative after discussions before the award of the contract. The QA programme shall be generally in line with ISO-9001/IS-14001. A quality assurance programme of the contractor shall generally cover the following:

a) His organisation structure for the management and implementation of the proposed quality assurance programme

b) Quality System Manual

c) Design Control System

d) Documentation Control System

e) Qualification data for Bidder's key Personnel.

f) The procedure for purchase of materials, parts, components and selection of sub-contractor's services including vendor analysis, source inspection, incoming raw-material inspection, verification of materials purchased etc.

g) System for shop manufacturing and site erection control including process controls and fabrication and assembly controls.

h) Control of non-conforming items and system for corrective actions.

i) Inspection and test procedure both for manufacture and field activities.

j) Control of calibration and testing of measuring testing equipments.

k) System for Quality Audits.

l) System for indication and appraisal of inspection status.

m) System for authorising release of manufactured product to the Employer.

n) System for handling storage and delivery.

o) System for maintenance of records, and

p) Furnishing of quality plans for manufacturing and field activities detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of equipment/component as per formats enclosed as **Annexure-I** and **Annexure-II** respectively.

22.00.00 **GENERAL REQUIREMENTS - QUALITY ASSURANCE**

22.01.00 All materials, components and equipment covered under this specification shall be procured, manufactured, erected, commissioned and tested at all the stages, as per a comprehensive Quality Assurance Programme. An indicative programme of inspection/tests to be carried out by the contractor for some of the major items is given in the respective technical specification. This is, however, not intended to form a comprehensive programme as it is the contractor's responsibility to draw up and implement such programme duly approved by the Employer. The detailed Quality Plans for manufacturing and field activities shall be drawn up by the Bidder and will be submitted to Employer for approval. Schedule of finalisation of such quality plans will be finalised before award on enclosed format No. QS-01-QAI-P-1/F3-R0. Monthly progress reports shall be furnished.

22.02.00 Manufacturing Quality Plan will detail out for all the components and equipment, various tests/inspection, to be carried out as per the requirements of this specification and standards mentioned therein and quality practices and procedures followed by Contractor's/ Sub-contractor's/ sub-supplier's Quality Control Organisation, the relevant reference documents and standards, acceptance norms, inspection documents raised etc., during all stages of materials procurement, manufacture, assembly and final testing/performance testing. The Quality Plan shall be submitted on electronic media through C-folders, a web based system of NTPC ERP in addition to hard copy, for review and approval. After approval the same shall be submitted in compiled form on CD-ROM (As per format at Annexure-I)

22.03.00 Field Quality Plans will detail out for all the equipment, the quality practices and procedures etc. to be followed by the Contractor's "Site Quality Control Organisation", during various stages of site activities starting from receipt of materials/equipment at site (As per format at Annexure – II).

22.04.00 The Bidder shall also furnish copies of the reference documents/plant standards/acceptance norms/tests and inspection procedure etc., as referred in Quality Plans along with Quality Plans. These Quality Plans and reference documents/standards etc. will be subject to Employer's approval without which manufacturer shall not proceed. These approved documents shall form a part of the contract. In these approved Quality Plans, Employer shall identify customer hold points (CHP), i.e. test/checks which shall be carried out in presence of the

	Employer's Project Manager or his authorised representative and beyond which the work will not proceed without consent of Employer in writing. All deviations to this specification, approved quality plans and applicable standards must be documented and referred to Employer along with technical justification for approval and dispositioning.
22.05.00	The contractor shall submit to the Employer Field Welding Schedule for field welding activities in the format enclosed at **Annexure-V.** The field welding schedule shall be submitted to the Employer along with all supporting documents, like welding procedures, heat treatment procedures, NDT procedures etc. at least ninety days before schedule start of erection work at site.
22.06.00	The contractor shall have suitable Field Quality Organization with adequate manpower at Employer's site, to effectively implement the Field Quality Plan (FQP) and Field Quality Management System for site activities. The contractor shall submit the details of proposed FQA setup (organizational structure and manpower) for employer's approval. The FQA setup shall be in place at least one month before the start of site activities.
22.07.00	No material shall be despatched from the manufacturer's works before the same is accepted, subsequent to predespatch final inspection including verification of records of all previous tests/inspections by Employer's Project Manager/Authorised representative and duly authorised for despatch by issuance of Material Despatch Clearance Certificate (MDCC).
22.08.00	All material used for equipment manufacture including casting and forging etc. shall be of tested quality as per relevant codes/standards. Details of results of the tests conducted to determine the mechanical properties; chemical analysis and details of heat treatment procedure recommended and actually followed shall be recorded on certificates and time temperature chart. Tests shall be carried out as per applicable material standards and/or agreed details
22.09.00	All welding and brazing shall be carried out as per procedure drawn and qualified in accordance with requirements of ASME Section IX/BS-4870 or other International equivalent standard acceptable to the Employer. All welding/brazing procedures shall be submitted to the Employer or its authorised representative for approval prior to carrying out the welding/brazing.
22.10.00	All brazers, welders and welding operators employed on any part of the contract either in Contractor's/his sub-contractor's works or at site or elsewhere shall be qualified as per ASME Section-IX or BS-4871 or other equivalent International Standards acceptable to the Employer.
22.11.00	All brazers, welders and welding operators employed on any part of the contract either in Contractor's/sub-contractor's works or at site or elsewhere shall be qualified

	as per ASME Section-IX or BS-4871 or other equivalent International Standards acceptable to the Employer..
22.12.00	For all IBR pressure parts and high pressure piping welding, the latest applicable requirements of the IBR (Indian Boiler Regulations) shall also be essentially complied with. However, other piping shall be as per relevant code. Similarly, any other statutory requirements for the equipment/systems shall also be complied with. On all back-gauged welds MPI/LPI shall be carried before seal welding
22.13.00	All the heat treatment results shall be recorded on time temperature charts and verified with recommended regimes.
22.14.00	No welding shall be carried out on cast iron components for repair.
22.15.00	Unless otherwise proven and specifically agreed with the Employer, welding of dissimilar materials and high alloy materials shall be carried out at shop only.
22.16.00	All non-destructive examination shall be performed in accordance with written procedures as per International Standards, The NDT operator shall be qualified as per SNT-TC-IA (of the American Society of non-destructive examination). NDT shall be recorded in a report, which includes details of methods and equipment used, result/evaluation, job data and identification of personnel employed and details of co-relation of the test report with the job. In general all plates of thickness greater than 40mm & for pressure parts plates of thickness equal to or greater than 25mm shall be ultrasonically tested otherwise as specified in respective equipment specification. All bar stock/Forging of diameter equal to or greater than 40 mm shall be ultrasonically tested..
22.17.00	The Contractor shall list out all major items/ equipment/ components to be manufactured in house as well as procured from sub-contractors (BOI). All the sub-contractor proposed by the Contractor for procurement of major bought out items including castings, forging, semi-finished and finished components/equipment etc., list of which shall be drawn up by the Contractor and finalised with the Employer, shall be subject to Employer's approval on enclosed format No. QS-01-QAI-P-01/F3. The contractor's proposal shall include vendor's facilities established at the respective works, the process capability, process stabilization, QC systems followed, experience list, etc. along with his own technical evaluation for identified sub-contractors enclosed and shall be submitted to the Employer for approval within the period agreed at the time of pre-awards discussion and identified in "DR" category prior to any procurement. Monthly progress reports on sub-contractor detail submission / approval shall be furnished preferably on enclosed format at **Annexure-IV.** Such vendor approval shall not relieve the contractor from any obligation, duty or responsibility under the contract.
22.18.00	For components/equipment procured by the contractors for the purpose of the

	contract, after obtaining the written approval of the Employer, the contractor's purchase specifications and inquiries shall call for quality plans to be submitted by the suppliers. The quality plans called for from the sub-contractor shall set out, during the various stages of manufacture and installation, the quality practices and procedures followed by the vendor's quality control organisation, the relevant reference documents/standards used, acceptance level, inspection of documentation raised, etc. Such quality plans of the successful vendors shall be finalised with the Employer and such approved Quality Plans shall form a part of the purchase order/contract between the Contractor and sub-contractor. With in three weeks of the release of the purchase orders /contracts for such bought out items /components, a copy of the same without price details but together with the detailed purchase specifications, quality plans and delivery conditions shall be furnished to the Employer on the monthly basis by the Contractor along with a report of the Purchase Order placed so far for the contract.
22.19.00	Employer reserves the right to carry out quality audit and quality surveillance of the systems and procedures of the Contractor's or their sub-contractor's quality management and control activities. The contractor shall provide all necessary assistance to enable the Employer carry out such audit and surveillance.
22.20.00	The contractor shall carry out an inspection and testing programme during manufacture in his work and that of his sub-contractor's and at site to ensure the mechanical accuracy of components, compliance with drawings, conformance to functional and performance requirements, identity and acceptability of all materials parts and equipment. Contractor shall carry out all tests/inspection required to establish that the items/equipment conform to requirements of the specification and the relevant codes/standards specified in the specification, in addition to carrying out tests as per the approved quality plan.
22.21.00	Quality audit/surveillance/approval of the results of the tests and inspection will not, however, prejudice the right of the Employer to reject the equipment if it does not comply with the specification when erected or does not give complete satisfaction in service and the above shall in no way limit the liabilities and responsibilities of the Contractor in ensuring complete conformance of the materials/equipment supplied to relevant specification, standard, data sheets, drawings, etc.
22.22.00	For all spares and replacement items, the quality requirements as agreed for the main equipment supply shall be applicable.
22.23.00	Repair/rectification procedures to be adopted to make the job acceptable shall be subject to the approval of the Employer/ authorised representative.
22.24.00	**Environmental Stress Screening** All solid state electronic system / equipment / sub assembly shall be free from infant mortile components. For establishing the compliance to this requirement, the

contractor / sub – contractor should meet the following.

1) The Contractor / Sub – contractor shall furnish the established procedure being followed for eliminating infant mortile components. The procedure followed by the Contractor / Sub – contractor should be substantiated along with the statistical figures to validate the procedure being followed. The necessary details as required under this clause shall be furnished at the stage of QP finalization.

Or

In case the Contractor / Sub – contractor do not have any established procedure to eliminate infant mortile components then two or 10% whichever is less, most densely populated Panels shall be tested for Elevated Temperature Cycle Test as per the following procedure.

Elevated Temperature Test Cycle

During the elevated temperature test which shall be for 48 hours, the ambient temperature shall be maintained at 50° C. The equipment shall be interconnected with devices and kept under energized conditions so as to repeatedly perform all operations it is expected to perform in actual service with load on various components being equal to those which will be experienced in actual service.

During the elevated temperature test the cubicle doors shall be closed (or shall be in the position same as they are supposed to be in the field) and inside temperature in the zone of highest heat dissipating components / modules shall be monitored. The temperature rise inside the cubicle should not exceed 10° C above the ambient temperature at 50° C.

In case of any failure during the test cycle, the further course of action should be mutually discussed for demonstrating the intent of the above requirement.

2) **Burn in Test Cycle**

The test shall be conducted on all the panels fully assembled and wired including the panels having undergone the above mentioned elevated temperature test.

The period of Burn in Test Cycle shall be 120 hrs and process shall be similar to the elevated temperature test as above except that the temperature shall be reduced to the ambient temperature prevalent at that time.

During the above tests, the process I/O and other load on the system shall

be simulated by simulated inputs and in the case of control systems; the process which is to be controlled shall also be simulated. Testing of individual components or modules shall not be acceptable.

During the Burn in Test the cubicle doors shall be closed (or shall be in the position same as they are supposed to be in the field) and inside temperature in the zone of highest heat dissipating components / modules shall be monitored. The temperature rise inside the cubicle should not exceed 10° C above the ambient temperature.

22.25.00 The Contractor / Sub-contractor shall carry out routine test on 100% item at contractor / sub-contractor's works. The quantum of check / test for routine & acceptance test by employer shall be generally as per criteria / sampling plan defined in referred standards. Wherever standards have not been mentioned quantum of check / test for routine / acceptance test shall be as agreed during detailed engineering stage.

23.00.00 **QUALITY ASSURANCE DOCUMENTS**

23.01.00 The Contractor shall be required to submit the QA Documentation in two hard copies and two CD ROMs, as identified in respective quality plan with tick (✓)mark.

23.01.01 Each QA Documentation shall have a project specific Cover Sheet bearing name & identification number of equipment and including an index of its contents with page control on each document.

The QA Documentation file shall be progressively completed by the Supplier's sub-supplier to allow regular reviews by all parties during the manufacturing.

The final quality document will be compiled and issued at the final assembly place of equipment before despatch. However CD-Rom may be issued not later than three weeks.

23.02.00 Typical contents of QA Documentation is as below:-

(a.) Quality Plan

(b.) Material mill test reports on components as specified by the specification and approved Quality Plans.

(c.) Manufacturer / works test reports/results for testing required as per applicable codes and standard referred in the specification and approved Quality Plans.

(d.) Non-destructive examination results /reports including radiography interpretation reports. Sketches/drawings used for indicating the method of traceability of the radiographs to the location on the equipment.

(e.) Heat Treatment Certificate/Record (Time- temperature Chart)

(f.) All the accepted Non-conformance Reports (Major/Minor)/deviation, including complete technical details / repair procedure).

(g.) CHP / Inspection reports duly signed by the Inspector of the Employer and Contractor for the agreed Customer Hold Points.

(h.) Certificate of Conformance (COC) wherever applicable.

(i.) MDCC

23.03.00 Similarly, the contractor shall be required to submit two sets (two hard copies and two CD ROMs), containing QA Documentation pertaining to field activities as per Approved Field Quality Plans and other agreed manuals/ procedures, prior to commissioning of individual system.

23.04.00 Before despatch / commissioning of any equipment, the Supplier shall make sure that the corresponding quality document or in the case of protracted phased deliveries, the applicable section of the quality document file is completed. The supplier will then notify the Inspector regarding the readiness of the quality document (or applicable section) for review.

(a.) If the result of the review carried out by the Inspector is satisfactory, the Inspector shall stamp the quality document (or applicable section) for release.

(b.) If the quality document is unsatisfactory, the Supplier shall endeavor to correct the incompleteness, thus allowing to finalize the quality document (or applicable section) by time compatible with the requirements as per contract documents. When it is done, the quality document (or applicable section) is stamped by the Inspector.

(c.) If a decision is made for despatch, whereas all outstanding actions cannot be readily cleared for the release of the quality document by that time, the supplier shall immediately, upon shipment of the equipment, send a copy of the quality document Review Status signed by the Supplier Representative to the Inspector and notify of the committed date for the completion of all outstanding actions & submission. The Inspector shall stamp the quality document for applicable section when it is effectively completed. The submission of QA documentation package shall not be later than 3 weeks after the despatch of equipment.

23.05.00 **TRANSMISSION OF QA DOCUMENTATION**

On release of QA Documentation by Inspector, one set of quality document shall be forwarded to Corporate Quality Assurance Department and other set to respective Project Site of Employer.

For the particular case of phased deliveries, the complete quality document to the Employer shall be issued not later than 3 weeks after the date of the last delivery of equipment.

24.00.00 **PROJECT MANAGER'S SUPERVISION**

24.01.00 To eliminate delays and avoid disputes and litigation, it is agreed between the parties to the Contract that all matters and questions shall be referred to the Project Manager and without prejudice to the provisions of 'Arbitration' clause in Section GCC, the Contractor shall proceed to comply with the Project Manager's decision.

24.02.00 The work shall be performed under the supervision of the Project Manager.

The scope of the duties of the Project Manager pursuant to the Contract, will include but not be limited to the following:

(a.) Interpretation of all the terms and conditions of these documents and specifications:

(b.) Review and interpretation of all the Contractor's drawing, engineering data, etc:

(c.) Witness or his authorised representative to witness tests and trials either at the manufacturer's works or at site, or at any place where work is performed under the contract :

(d.) Inspect, accept or reject any equipment, material and work under the contract :

(e.) Issue certificate of acceptance and/or progressive payment and final payment certificates

(f.) Review and suggest modifications and improvement in completion schedules from time to time, and

(g.) Supervise Quality Assurance Programme implementation at all stages of the works.

25.00.00	**INSPECTION, TESTING AND INSPECTION CERTIFICATES**
25.01.00	The word 'Inspector' shall mean the Project Manager and/or his authorised representative and/or an outside inspection agency acting on behalf of the Employer to inspect and examine the materials and workmanship of the works during its manufacture or erection.
25.02.00	The Project Manager or his duly authorised representative and/or an outside inspection agency acting on behalf of the Employer shall have access at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection and if part of the works is being manufactured or assembled on other premises or works, the Contractor shall obtain for the Project Manager and for his duly authorised representative permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works.
25.03.00	The Contractor shall give the Project Manager/Inspector fifteen (15) days written notice of any material being ready for testing. Such tests shall be to the Contractor's account except for the expenses of the Inspector's. The Project Manager/Inspector, unless the witnessing of the tests is virtually waived and confirmed in writing, will attend such tests within fifteen (15) days of the date on which the equipment is noticed as being ready for test/inspection failing which the contractor may proceed with test which shall be deemed to have been made in the inspector's presence and he shall forthwith forward to the inspector duly certified copies of test reports in two (2) copies.
25.04.00	The Project Manager or Inspector shall within fifteen (15) days from the date of inspection as defined herein give notice in writing to the Contractor, or any objection to any drawings and all or any equipment and workmanship which is in his opinion not in accordance with the contract. The Contractor shall give due consideration to such objections and shall either make modifications that may be necessary to meet the said objections or shall inform in writing to the Project Manager/Inspector giving reasons therein, that no modifications are necessary to comply with the contract.
25.05.00	When the factory tests have been completed at the Contractor's or sub-contractor's works, the Project Manager /Inspector shall issue a certificate to this effect fifteen (15) days after completion of tests but if the tests are not witnessed by the Project Manager /Inspectors, the certificate shall be issued within fifteen (15) days of the receipt of the Contractor's test certificate by the Project Manager /Inspector. Project Manager /Inspector to issue such a certificate shall not prevent the Contractor from proceeding with the works. The completion of these tests or the issue of the certificates shall not bind the Employer to accept the equipment should it, on further tests after erection be found not to comply with the contract.
25.06.00	In all cases where the contract provides for tests whether at the premises or works of the Contractor or any sub-contractor, the Contractor, except where otherwise

	specified shall provide free of charge such items as labour, material, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Project Manager /Inspector or his authorised representatives to carry out effectively such tests on the equipment in accordance with the Contractor and shall give facilities to the Project Manager/Inspector or to his authorised representative to accomplish testing.
25.07.00	The inspection by Project Manager / Inspector and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed Quality Assurance Programme forming a part of the contract.
25.08.00	To facilitate advance planning of inspection in addition to giving inspection notice as specified at clause no 9.05.03- of this chapter, the Contractor shall furnish quarterly inspection programme indicating schedule dates of inspection at Customer Hold Point and final inspection stages. Updated quarterly inspection plans will be made for each three consecutive months and shall be furnished before beginning of each calendar month.
25.09.00	All inspection, measuring and test equipment used by contractor shall be calibrated periodically depending on its use and criticality of the test/measurement to be done. The Contractor shall maintain all the relevant records of periodic calibration and instrument identification, and shall produce the same for inspection by NTPC. Wherever asked specifically, the contractor shall re-calibrate the measuring/test equipment in the presence of Project Manager / Inspector.
25.10.00	**Associated document for Quality Assurance programme**
25.10.01	Manufacturing Quality Plan Format No. : QS-01-QAI-P-09/F1-R1 enclosed at **Annexure-I.**
25.10.02	Field Quality Plan Format No.: QS-01-QAI-P-09/F2-R1 enclosed at **Annexure-II.**
25.10.03	List of items requiring quality plan and sub supplier approval. Format No.: QS-01-QAI-P-01/F3-R0 **(Annexure-III).**
25.10.04	Status of items requiring Quality Plan and sub supplier approval. Format enclosed at **Annexure-IV.**
25.10.05	Field Welding Schedule Format enclosed at **Annexure-V.**
25.11.00	**TESTING OF MAJOR DESIGN FEATURES:**
	The major design features of the system shall be demonstrated by the Contractor at the Contractor's works or any other place mutually agreed within Six months from the date of LOA. These are the system function tests, which have a major impact on the detailed system design & finalization of important engineering documents like

configuration, functional grouping, BOM etc., but do not require a fully engineered system for conductance. Bidder shall identify these features & include detailed test procedures in the bid, which shall be finalized during discussions with the bidder before award. The developments and any augmentation of standard features undertaken by the Bidder to fulfill the various specification requirements, shall be also be tested during these major design tests. This shall include but not be limited to the following.

a) System accuracy tests of DDCMIS for the various type of inputs identified in Part-B.

b) Loop reaction time for sample loops/ logics.

c) SOE functionality tests.

d) Server changeover.

e) Various response times, having serious implication on operation & maintenance philosophy.

f) Duty cycle of controller/ HMIPIS with simulated load, representative of the final engineered load.

g) Unified HMI for DDCMIS.

The results of the above tests, after its acceptance by the Employer, shall be properly documented and submitted to Employer.

If any of the envisaged tests have been carried out by Bidder in a previous NTPC project, then the same need not be specifically conducted by the Bidder for this project, provided it is clearly established by the Bidder & accepted by the Employer that there is no difference between the system offered for this project & the previous NTPC project with respect to the test. However, even in such a case, test report of the previous project shall be submitted by the Bidder as a part of MDFT (Major Design Feature Test) test report.

25.12.00 **DEMONSTRATION OF APPLICATION ENGINEERING**

25.12.01 Based on NTPC inputs, the Contractor shall prepare and submit typical implemented scheme in their system (Control system & HMI) on sample basis. The typical cases to be covered shall include but not be limited to the following.

(i) Logics/Loops:

a) Drive logics implementation for each type of binary drive along with its display in HMI.

b) Sequence implementation along with its display in HMI.

c) Single non-cascade controller implementation.

d) Cascade loop implementation.

e) Master slave implementation with different slave combination.

f) Temperature & pressure compensation for flow signals & pressure compensation for level signals as applicable.

(ii) HMI Functions:

a) LVS Annunciation.

b) Graphics.

c) HSR

d) Logs/Reports.

e) Calculations (Basic & Performance Calculations).

25.12.02 The above typical cases shall be finalized with the Employer through Technical Co-ordination meetings.

After review and finalization of the typical cases, the implementation of each logic & control loop shall be carried out by the Contractor based on NTPC inputs. After implementation of these logics & loops, the Contractor shall test each logic /loop and record the observations in a format to be provided by the Employer and demonstrate to Employer at Employer premises during engineering finalization. Any modifications as a result of the demonstration shall be done and documented as part of the test report along with the final scheme. Similarly, HMI functions shall also be demonstrated by the Contractor at Employer premises & the results shall be documented as part of test report.

25.12.03 During the integrated testing at the Contractor's works, only sample checks shall be done by the Employer for the items covered in above application engineering demonstration.

26.00.00 **PRE-COMMISSIONING AND COMMISSIONING FACILITIES**

26.01.00 (a) As soon as the facilities or part thereof has been completed operationally and structurally and before start-up, each item of the equipment and systems forming part of facilities shall be thoroughly cleaned and then inspected jointly by the Employer and the Contractor for correctness of and completeness of facility or part thereof and acceptability for initial pre-

commissioning tests, commissioning and start-up at Site. The list of pre-commissioning tests to be performed shall be as mutually agreed and included in the Contractor's quality assurance programme as well as those included in Part-D, Section-VI and elsewhere in the Technical Specifications.

(b) The Contractor's pre-commissioning/ commissioning/start-up engineers, specially identified as far as possible, shall be responsible for carrying out all the pre-commissioning tests at Site. On completion of inspection, checking and after the pre-commissioning tests are satisfactorily over, the commissioning of the complete facilities shall be commenced during which period the complete facilities, equipments shall be operated integral with sub-systems and supporting equipment as a complete plant.

(c) All piping system shall be flushed, steam blown, air blown as required and cleanliness demonstrated using acceptable industry standards. Procedures to accomplish this work shall be submitted for approval to the Employer six months prior to the respective implementations. The Employer will approve final verification of cleanliness.

(d) The time consumed in the inspection and checking of the units shall be considered as a part of the erection and installation period.

(e) The check outs during the pre - commissioning period should be programmed to follow the construction completion schedule. Each equipment/system, as it is completed in construction and turned over to Employer's commissioning (start-up) Engineer(s), should be checked out and cleaned. The checking and inspection of individual systems should then follow a prescribed schedule to be agreed by Employer.

(f) The Contractor during initial operation and performance testing shall conduct vibration testing to determine the 'base line' of performance of all plant rotating equipment. These tests shall be conducted when the equipment is running at the base load, peak load as well as lowest sustained operating condition as far as practicable.

26.01.00 Contractor shall furnish the commissioning organization chart for review & acceptance of employer at least eighteen months prior to the schedule date of synchronization of 1st unit. The chart should contain :

(1.) Biodata including experience of the Commissioning Engineers.

(2.) Role and responsibilities of the Commissioning Organisation members.

(3.) Expected duration of posting of the above Commissioning Engineers at site.

26.02.00 **Initial Operation**

(a) On completion of all pre-commissioning activities/ tests and as a part of commissioning the complete facilities shall be put on 'Initial Operation' during which period all necessary adjustments shall be made while operating over the full load range enabling the facilities to be made ready for the Guarantee Tests.

(b) The 'Initial Operation' of the complete facility as an integral unit shall be conducted for 720 continuous hours. During the period of initial operation of 720 hours, the unit shall operate continuously at full rated load for a period not less than 72 hours.

The Initial Operation shall be considered successful, provided that each item/ part of the facility can operate continuously at the specified operating characteristics, for the period of Initial Operation with all operating parameters within the specified limits and at or near the predicted performance of the equipment/ facility.

The Contractor shall intimate the Employer about the commencement of initial operation and shall furnish adequate notice to the Employer in this respect.

(c) Any loss of generation due to constraints attributable to the Employer shall be construed as Deemed Generation.

(d) An Initial Operation report comprising of observations and recordings of various parameters to be measured in respect of the above Initial Operation shall be prepared by the Contractor. This report, besides recording the details of the various observations during initial operation shall also include the dates of start and finish of the Initial Operation and shall be signed by the representatives of both the parties. The report shall have sheets, recording all the details of interruptions occurred, adjustments made and any minor repairs done during the Initial Operation. Based on the observations, necessary modifications/repairs to the plant shall be carried out by the Contractor to the full satisfaction of the Employer to enable the latter to accord permission to carry out the Guarantee tests on the facilities. However, minor defects which do not endanger the safe operation of the equipment, shall not be considered as reasons for with- holding the aforesaid permission.

26.03.00 **Guarantee Tests**

a) The final test as to prove the Functional Guarantees shall be conducted at Site by the Contractor in presence of the Employer. The contractor's Commissioning, start-up and initial operation shall make the unit ready to

conduct such test. Such test will be commenced, within a period of **three (3) months** after the successful completion of Initial Operations. Any extension of time beyond the above **three (3) months** shall be mutually agreed upon.

b) These tests shall be binding on both the parties of the Contract to determine compliance of the equipment with the functional guarantee.

c) For performance/ demonstration tests instrumentations, of accuracy class shall be as per specified test codes. The numbers and location of the instruments shall be as per the specified test codes. In addition the values of parameters shall be logged from the information system provided under Employer's Distributed Digital Control Monitoring and Information system. Test will be conducted at specified load points.

d) Any special equipment, tools and tackles required for the successful completion of the Guarantee Tests shall be provided by the Contractor, free of cost.

e) The Guarantee tests and specific tests to be conducted on equipments have been brought out in detail elsewhere in the specifications.

27.00.00 **TAKING OVER**

Upon successful completion of Initial Operations and all the tests,other than Guarantee Tests conducted to the Employer's satisfaction, the Employer shall issue to the Contractor a Taking over Certificate as a proof of the final acceptance of the equipment. Such certificate shall not unreasonably be with held nor will the Employer delay the issuance thereof, on account of minor omissions or defects which do not affect the commercial operation and/or cause any serious risk to the equipment. Such certificate shall not relieve the Contractor of any of his obligations which otherwise survive, by the terms and conditions of the Contract after issuance of such certificate.

28.00.00 **TRAINING OF EMPLOYER'S PERSONNEL**

28.01.00 The scope of service under training of Employer’s engineers shall include a training module covering the areas of Operation & Maintenance.

Such training should cover the following areas as a minimum in order to enable these personnel to individually take the responsibility of operating and maintaining the power station in a manner acceptable to the Employer:

(a) Training for Steam Generator & ESP Equipment, TG & Auxiliaries and related equipments.

(b) Training for Electric Systems including VFD and Electric power supply system.

(c) Training for other SG/TG related C&I systems/equipments including training on Flame Monitoring System, Furnace and Flame Viewing System , Turbine Supervisory System (TSS) including vibration analyzer, vibration monitoring system axial shift, eccentricity measurements etc. for Main Turbine, BFP Turbine etc. Burner management study, control loop study, misc system for SG C&I, EHTC, Turbine stress control system, Turbine protection system, ATRS, instrumentation etc.

(d) Training for special packages for various PC based systems specified elsewhere in Part-B of Technical Specification, Section-VI.

(e) Training for various C&I systems/equipment supplied includes the following:

i) DDCMIS - Human Machine Interface – Hardware & Operating System

ii) DDCMIS-Human Machine Interface System Engineering & Application Software.

iii) DDCMIS – Control System Hardware and Control system Application Software.

iv) DDCMIS – Operator Training : Use of the system at Works + at site.

v) DDCMIS – Specialized Network security.

(f) Training for power cycle piping/critical piping.

(g) Training for UPS systems Annunciation system, SWAS, PA system, flue gas analyzers, CCTV and 24 VDC system.

(h) Training for numerical relays & networking systems supplied under MV & LT switchgear system.

(i) Training for Simulator System

(j) Details of training modules for SG, TG, Electrical, C&I systems and Simulator System are given at **Annexure – VII, VIII, IX, X, XI & XII.**

The exact details, extent and schedule for training shall be as finalized during detailed engineering and shall be subject to Employer's approval.

28.03.00 The scope of services under training shall also necessarily include training of Employer’s Engineering personnel covering a training module as indicated in **Annexure – VII, VIII, IX, X, XI & XII** . This shall cover all disciplines viz, Mechanical, Electrical, C&I , QA etc. and shall include all the related areas like Design familiarization, training on product design features and product deign software of major equipment and systems, engineering, manufacturing, erection, commissioning, training on operating features of equipment, quality assurance and testing, plant visits and visits to manufacturer’s works, exposure to various kinds of

	problems which may be encountered in fabrication, manufacturing erection, welding etc.
28.04.00	Contractor shall also arrange for training of Employer's personnel in respect of fire detection and protection systems and other Balance of Plant equipments.
28.05.00	Bidder shall furnish in his offer, details of training module(s) covering above requirements which shall be subject to Employer's approval. Consolidated training period included above [i.e. **Annexure – VII, VIII, IX, X, XI & XII** for O&M and Engineering] is indicative only. Employer reserves the right to reappropriate the training period between O&M and engineering depending upon the details of training module proposed by the Bidder.
28.06.00	Exact details, extent of training and the training schedule shall be finalized based on the Bidder's proposal within two (2) months from placement of award.
28.07.00	In all the above cases, wherever the training of Employer's personnel is arranged at the works of the manufacturer's it shall be noted that the lodging and boarding of the Employer's personnel shall be at the cost of Bidder. The Bidder shall make all necessary arrangements towards the same.
28.08.00	Take off prices (product wise) should be indicated by the Bidder in the Bid Proposal Sheets. Employer reserves the right to include or exclude these item(s) during placement of Award. **Note**: For training purposes, one (1) man month implies 30 working days (excluding all intervening holidays) per person.
29.00.00	**SAFETY ASPECTS DURING CONSTRUCTION AND ERECTION** In addition to the requirements given in Erection Conditions of Contract (ECC) the following shall also cover: i) Working platforms should be fenced and shall have means of access. ii) Ladders in accordance with Employer's safety rules for construction and erection shall be used. Rungs shall not be welded on columns. All the stairs shall be provided with handrails immediately after its erection.
30.00.00	**NOISE LEVEL** The equivalent 'A' weighted sound pressure level measured at a height of 1.5 m above floor level in elevation and at a distance of one (1) metre horizontally from the nearest surface of any equipment/machine, furnished and installed under these specifications, expressed in decibels to a reference of 0.0002 microbar, shall not exceed 85 dBA except for

i) Safety valves and associated vent pipes for which it shall not exceed 105 dBA-115 dBA.

ii) Regulating drain valves in which case it shall be limited to 90 dBA-115 dBA.

iii) Mill noise which will be limited to 85-90 dBA.

iv) TG unit in which case it shall not exceed 90 dBA.

v) For HP-LP bypass valves and other intermittantly operating control valves, the noise level shall be within the limit of 90 dBA.

vi) For BFP Motor Noise level shall be with in the limit of 90 dBA.

31.00.00 **PACKAGING AND TRANSPORTATION**

All the equipments shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. While packing all the materials, the limitation from the point of view of the sizes of railway wagons available in India should be taken account of. The Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. The Contractor shall ascertain the availability of Railway wagon sizes from the Indian Railways or any other agency concerned in India well before effecting despatch of equipment. Before despatch it shall be ensured that complete processing and manufacturing of the components is carried out at shop, only restricted by transport limitation, in order to ensure that site works like grinding, welding, cutting & preassembly to bare minimum. The Employer's Inspector shall have right to insist for completion of works in shops before despatch of materials for transportation.

32.00.00 **ELECTRICAL EQUIPMENTS/ENCLOSURES**

32.01.00 All electrical equipments and devices, including insulation, heating and ventilation devices shall be designed for ambient temperature and a maximum relative humidity as specified elsewhere in the specifications.

33.00.00 **INSTRUMENTATION AND CONTROL**

All instrumentation and control systems/ equipment/ devices/ components, furnished under this contract shall be in accordance with the requirements stated herein, unless otherwise specified in the detailed specifications.

33.01.00 All instrument scales and charts shall be calibrated and printed in metric units and shall have linear graduation. The ranges shall be selected to have the normal reading at 75% of full scale.

All scales and charts shall be calibrated and printed in Metric Units as follows:

1 Temperature	-	Degree centigrade (deg C)
2. Pressure	-	Kilograms per square centimetre (Kg/cm^2). Pressure instrument shall have the unit suffixed with 'a' to indicate absolute pressure. If nothing is there, that will mean that the indicated pressure is gauge pressure.
3. Draught	-	Millimetres of water column (mm wc).
4. Vacuum	-	Millimeters of mercury gauge (mm Hg) or water column (mm Wcl).
5. Flow (Gas)	-	Tonnes/ hour
6. Flow (Steam)	-	Tonnes/ hour
7. Flow (Liquid)	-	Tonnes / hour
8. Flow base	-	760 mm Hg. 15 deg.C
9. Density	-	Grams per cubic centimetre.

33.02.00 All instruments and control devices provided on panels shall be of miniaturized design, suitable for modular flush mounting on panels with front draw out facility and flexible plan-in connection at rear.

33.03.00 All electronic modules shall have gold plated connector fingers and further all input and output modules shall be short circuit proof. These shall also be tropicalised & components shall be of industrial grade or better.

34.00.00 **ELECTRICAL NOISE CONTROL**

The equipment furnished by the Contractor shall incorporate necessary techniques to eliminate measurement and control problems caused by electrical noise. Areas in Contractor's equipment which are vulnerable to electrical noise shall be hardened to eliminate possible problems. Any additional equipment, services required for effectively eliminating the noise problems shall be included in the proposal. The equipment shall be protected against ESD as per IEC-61000-2. Radio Frequency interference (RFI) and Electro Magnetic Interference (EMI) protection against hardware damage and control system mal-operations/errors shall be provided for all systems as per EN-50082-2 (1995).

35.00.00 **SURGE PROTECTION FOR SOLID STATE EQUIPMENT**

All solid state systems /equipment shall be able to withstand the electrical noise and surge as encountered in actual service conditions and inherent in a power plant and shall meet the requirements of surge protection as defined in ANSI C37.90.1-1989 on its suitable equivalent class of IEC 254-4. Details of the features incorporated and relevant tests carried out. The test certificates. etc. shall be submitted by the Bidder.

36.00.00 **INSTRUMENT AIR SYSTEM**

The instrument air supply system as supplied by the Bidder for various pneumatic control & instrumentation devices like pneumatic actuators, power cylinders, E/P converters, piping / tubing etc.

Each pneumatic instrument shall have an individual air shut - off valve. The pressure regulating valve shall be equipped with an internal filter, a 50 mm pressure gauge and a built-in filter housing blow down valve.

37.00.00 **TAPPING POINTS FOR MEASUREMENTS**

Tapping points shall include probes, wherever applicable, for analytical measurements and sampling.

For direct temperature measurement of all working media, one stub with internal threading of approved pattern shall be provided along with suitable plug and washer. The Contractor will be intimated about thread standard to be adopted.

The following shall be provided on equipment by the Bidder. The standard which is to be adopted, will be intimated to the Contractor.

i) Temperature test pockets with stub and thermowell

ii) Pressure test pockets

38.00.00 **SYSTEM DOCUMENTATION**

The Bidder shall provide drawings, system overview & description, hardware/ software details, technical literature, functional & hardware schemes, bill of material, parts list, interconnection diagrams, data sheets, erection/ installation/ commissioning procedures, instruction/ operating manuals, etc. for each of the C& I system / sub-systems/ equipment supplied under this package. The documentation shall include complete details of the C&I systems/ sub-systems/ equipment to enable review by Employer during detailed engineering stage and to provide information to plant personnel for operation & Maintenance (including quick diagnostics & trouble shooting) of these C&I systems/ sub-systems/ equipment at site. The minimum

documentation requirements for C&I systems shall be as stipulated under C&I "Techncial Data Sheets" Part of specifications. In addition to this, system documentation for DDCMIS shall include as a minimum to that specified elsewhere in the Technical Specification.

The exact format, submission schedule and contents of various documents shall be as finalised during detailed engineering stage.

38.01.00 Bill of material (instrument list) for all C&I equipment/ devices shall be furnished by the bidder in standard formats as approved by the Employer.

39.00.00 **MAINTENANCE MANUALS OF ELECTRONIC MODULES**

The Contractor shall have to furnish two(2) sets of all maintenance manual of each and every electronic card/module as employed on the various systems and equipment including peripherals etc., offered by him.The Contractor will also have to furnish the data regarding the expected failure rate of various modules and other system components. Further , the contractor shall furnish a set of operating manuals which should include block diagrams ,make, model/type ,details wiring and external connection drawings etc as required to do the testing and maintenance of the electronic modules.

LIST OF CODES AND STANDARDS

Indian Standards	Title	International and Internationally recognised standards
IS:277	Galvanised steel sheets (plain or corrugated)	
IS:655	Specification for metal air duct	
IS:800	Code of practice for use of structural steel in general building construction	BS 449:1969 BS 5950 ASA A57, 1-1952
IS:807	Code of practice for design, manufacture, erection and testing (Structural portion) of cranes and hoists 6588 (Issued by Standards Associa-tion of Australia). DIN 120:1936 (Sheet 1) DIN 120:1936 (Sheet 2) 327 part-I, 1951 BS 466 part-II, 1960 BS 644:1960 BS 1757:1951 BS 2573:part-I:1960	Draft Revision of A.S. NO. CS.2 SAA Crane and Hoist code Doc:No. BU/4 Rev
IS:875	Code of practice for design loads (other than earthquake) for buildings and structures Leading standards (issued by Canadian Standard) DIN-1055-1955 (Issued by ASA)	National Building code of Canada (1953)-Part-IV Design section 4.1
IS:1239 Part-I	Mild steel tubes	(ISO/R 65-1957) (ISO/R-64-1958)

		(ISO/R-65-1958) (BS 1387 : 1957)
IS:1239 Part-II	Mild steel tubulars and other wrought steel pipe fittings	BS 1387 : 1967 BS 1387 :1967 BS 1740 :1965
IS:2825	Code for unfired vessels	
IS:1520	Horizontal centrifugal pumps for clear cold and fresh water	
IS:1600	Code for practice for performance of constant speed IC Engines for general purpose	
IS:1601	Specification for perform-ance of constant speed IC Engines for general Purpose	
IS:1893	Criteria for earthquake resistant design of structures	
IS1978-1971	Line Pipe April 1969.	API Standards 5L
IS:2254-1970	Dimensions of vertical shaft motor for pumps	IEC Pub 72-1 part I NEMA Pub MG 1 1954
IS:2266	Steel wire ropes for general engineering purposes	BS :302 : 1968
IS:2312	Propellant type Ventilation fans	
IS:2365	Steel wire suspension ropes for lifts and hoists	BS : 1957
IS:3346	Method for the determin-ation of thermal	DIN 52612 (Deutscher Normenausschuss)

		conductivity of thermal insulation materials (two slab guarded hot plate method)	ASTM C 163-1964 (American Society of Testing and materials) ASTM C 167-1974 ASTM C 177-1963
	IS:3354	Outline dimensions for electric lifts.	
	IS:3401	Silica gel	
	IS:3588	Specification for electrical axial flow fans	
	IS:3589	Electrically welded steel pipes for water, gas and sewage (200mm to 2000 mm Nominal Diametre)	
	IS:3677	Unbonded rock and slag wool for thermal insulation	
	IS:3815	Point hook with shank for general engineering purposes	BS 482 - 1968 Doc.:67/3 1284 (Revision of BS 2903) (Issued BS)
	IS:3895	Specification for monocry-stallines semiconductor rectifier cells and stacks	
	IS:3963	Roof extractor unit	
	IS:3975	Mild steel wires, strips and tapes for armouring cables	
	IS:4503	Shell and tube type heat Exchanger	
	IS:4540	Specification for monory-stallines rectifire assembly	

		equipment	
	IS:4671	Expanded polystyrene for thermal insulation purpose	
	IS:4736	Hot dip zinc coating on steel tubes	
	IS:4894	Centrifugal fans	
	IS:5456	Code of practice for testing of positive displacement type air compressors and exhauster (For Test Tolerance Only)	
	IS:5749	Forged ramshorn hooks	Entwurf DIN 15402 Blett 1 Entwurf DIN 15402 BS 3017-1958
	IS:6392	Steel pipe flanges	BS 4504 : 1969
	IS:6524 Part-I	Code of practice for design of tower cranes Static and rail mounted	BS 2799 : 1956
	IS:7098	Cross linked Polyethylene insulated PVC sheathed cables	Standard No. 1 to IPCEA (USA) Pub. No. 5-66-524
	IS:7373	Specification for wrought aluminium and aluminium sheet and strips	
	IS:7938	Air receivers for compressed air installation	
	ISO:1217	Displacement compressor-Acceplance test	
	ASHRAE-33 and air heating coils.	Methods of testing for rating of forced circulation air cooling	
	ASHRAE-52-76 particle matter.	Air cleaning device used in general ventilation for removing	

ASHRAE-22-72	Method of testing for rating of water cooled refrigerant condensers.
ASHRAE 23-67	Methods of testing for rating of positive displacement refrigerant compressors.
ARI-450-6	Standard for water cooled refrigerant condensers.
ARI-550	Standard for centrifugal water chilling packages.
ARI-410	Standard for forced circulation air cooling and air heating coils
ARI-430/435 BS:848 (Part-1,2)	Central station AHU/Application of Central Station AHU Fans
BS:400	Low carbon steel cylinders for the storage & transport of permanent gases.
BS:401	Low carbon steel cylinders for the storage & transport of liquified gases.
CTI Code ACT-105	Acceptance test code for Water Cooling Tower.
ANSI-31.5	Refrigerant piping
ASME-PTC- 23-1958	Atmospheric Water Cooling Equipment
AMCA A-21C	Test Code for air moving devices
API:618	Reciprocating Compressor for general refinary services.

HYDRAULIC INSTITUTE STANDARDS.

HYDRANT SYSTEM MANUALS OF TAC.

TAC MANUALS OF SPRAY SYSTEM

NFPA USA/ NSC UK/ UL USA/ FM USA STANDARDS.

INDIAN EXPLOSIVES ACT.

INDIAN FACTORIES ACT.

STANDARD OF TUBULAR EXCHANGER MANUFACTURER'S ASSOCIATION.

CODE AND STANDARD FOR CIVIL WORKS

Some of the applicable Standards, Codes and references are as follows:

Excavation & Filling

IS: 2720 (Part-II, IV TO VIII, XIV, XXI, XXIII, XXIV, XXVII TO XXIX, XL) Methods of test for soils-determination for water content etc.

IS: 4701 Code of practice for earth work on canals.

IS: 9758 Guide lines for Dewatering during construction.

IS: 10379 Code of practice for field control of moisture and compaction of soils for embankment and sub-grade.

Properties, Storage and Handling of Common Building Materials

IS: 269 Specification for ordinary Portland cement, 33 grade.

IS: 383 Specification for coarse and fine aggregates from natural sources for concrete.

IS: 432 Specification for mild steel and (Parts 1&2) medium tensile steel bars and hard-drawn steel wires for concrete reinforcement.

IS: 455 Specification for Portland slag cement.

IS: 702 Specification for Industrial bitumen.

IS: 712 Specification for building limes.

IS: 808 Rolled steel Beam channel and angle sections.

IS: 1077 Specification for common burnt clay building bricks.

IS: 1161 Specification of steel tubes for structural purposes.

IS: 1363 Hexagon head Bolts, Screws and nuts of production grade C.

IS: 1364 Hexagon head Bolts, Screws and Nuts of Production grade A & B.

IS: 1367 Technical supply conditions for Threaded fasteners.

IS: 1489 Specification for Portland-pozzolana cement:

(Part-I) Fly ash based.

(Part-II)	Calcined clay based.
IS: 1542	Specification for sand for plaster.
IS: 1566	Specification for hard-drawn steel wire fabric for concrete reinforcement.
IS: 1786	Specification for high strength deformed bars for concrete reinforcement.
IS: 2062	Specification for steel for general structural purposes.
IS: 2116	Specification for sand for masonry mortars.
IS: 2386 (Parts-I to VIII)	Testing of aggregates for concrete.
IS: 3150	Hexagonal wire netting for general purpose.
IS: 3495 (Parts-I to IV)	Methods of tests of burnt clay building bricks.
IS: 3812	Specification for fly ash, for use as pozzolana and admixture.
IS: 4031	Methods of physical tests for hydraulic cement.
IS: 4032	Methods of chemical analysis of hydraulic cement.
IS: 4082	Recommendations on stacking and storage of construction materials at site.
IS: 8112	Specification for 43 grade ordinary portland cement.
IS: 8500	Medium and high strength structural steel.
IS: 12269	53 grade ordinary portland cement.
IS: 12894	Specification for Fly ash lime bricks.

Cast-In-Situ Concrete and Allied Works

IS: 280	Specification for mild steel wire for general engineering purposes.
IS: 456	Code of practice for plain and reinforced concrete.

	IS: 457	Code of practice for general construction of plain & reinforced concrete for dams & other massive structures.
	IS: 516	Method of test for strength of concrete.
	IS: 650	Specification for standard sand for testing of cement.
	IS: 1199	Methods of sampling and analysis of concrete.
	IS: 1791	General requirements for batch type concrete mixers.
	IS: 1838 (Part-I)	Specification for preformed fillers for expansion joints in concrete pavements and structures (non-extruding and resilient type).
	IS: 2204	Code of practice for construction of reinforced concrete shell roof.
	IS: 2210	Criteria for the design of reinforced concrete shell structures and folded plates.
	IS: 2438	Specification for roller pan mixer.
	IS: 2502	Code of practice for bending and fixing of bars for concrete reinforcement.
	IS: 2505	General requirements for concrete vibrators, immersion type.
	IS: 2506	General requirements for concrete vibrators, screed board type.
	IS: 2514	Specification for concrete vibrating tables.
	IS: 2645	Specification for Integral cement water proofing compounds.
	IS: 2722	Specification for portable swing weigh batches for concrete. (single and double bucket type)
	IS: 2750	Specification for Steel scaffolding.
	IS: 2751	Code of practice for welding of mild steel plain and deformed bars for reinforced concrete construction.
	IS: 3025	Methods of sampling and test waste water.
	IS: 3366	Specification for Pan vibrators.
	IS: 3370	Code of practice for concrete structures for the storage of

	(Part I to IV)	liquids.
	IS: 3414	Code of practice for design and installation of joints in buildings.
	IS: 3550	Methods of test for routine control for water used in industry.
	IS: 3558	Code of practice for use of immersion vibrators for consolidating concrete.
	IS: 4014 (Parts I & II)	Code of practice for steel tubular scaffolding.
	IS: 4326	Code of practice for earthquake resistant design and construction of buildings.
	IS: 4461	Code of practice for joints in surface hydro-electric power stations.
	IS: 4656	Specification for form vibrators for concrete.
	IS: 4925	Specification for batching and mixing plant.
	IS: 4990	Specification for plywood for concrete shuttering work.
	IS: 4995 (Parts I & II)	Criteria for design of reinforced concrete bins for the storage of granular and powdery materials.
	IS: 5256	Code or practice for sealing joints in concrete lining on canals.
	IS: 5525	Recommendations for detailing of reinforcement in reinforced concrete work.
	IS: 5624	Specification for foundation bolts.
	IS: 6461	Glossary of terms relating to cement concrete.
	IS: 6494	Code of practice for water proofing of underground water reservoirs and swimming pools.
	IS: 6509	Code of practice for installation of joints in concrete pavements.
	IS: 7861	Code of practice for extreme weather concreting. (Parts I & II)
	IS: 9012	Recommended practice for shot concreting.
	IS: 9103	Specification for admixtures for concrete.

IS: 9417	Recommendations for welding cold worked steel bars for reinforced concrete construction.
IS: 10262	Recommended guidelines for concrete mix design.
IS: 11384	Code of practice for composite construction in structural steel and concrete.
IS: 11504	Criteria for structural design of reinforced concrete natural draught cooling towers.
IS: 12118	Specification for two-parts poly sulphide.
IS: 12200	Code of practice for provision of water stops at transverse contraction joints in masonry and concrete dams.
IS: 13311	Method of non-destructive testing of concrete.
Part-1	Ultrasonic pulse velocity.
Part-2	Rebound hammer.
SP:23	Handbook of concrete mixes
SP: 24	Explanatory Handbook on IS: 456-1978
SP: 34	Handbook on concrete reinforcement and detailing.

Precast Concrete Works

SP: 7(PartVI/	National Building Code- Structural design of prefabrication and Sec.7) systems building.
IS: 10297	Code of practice for design and construction of floors and roofs using precast reinforced/prestressed concrete ribbed or cored slab units.
IS: 10505	Code of practice for construction of floors and roofs using pre-cast reinforced concrete units.

Masonary and Allied Works

IS: 1905	Code of Practice for Structural Safety of Buildings-Masonry walls.
IS: 2212	Code of Practice for Brickwork.

IS: 2250	Code of Practice for Preparation and use of Masonry Mortar.
SP: 20	Explanatory hand book on masonry code.
Sheeting Works	
IS:277	Galvanised steel sheets (plain or corrugated).
IS: 459	Unreinforced corrugated and semi-corrugated asbestos cement sheets.
IS: 513	Cold-rolled carbon steel sheets.
IS: 730	Specification for fixing accessories for corrugated sheet roofing.
IS: 1626	Specification for Asbestos cement building pipes and pipe fittings, gutters and gutter fittings and roofing fittings.
IS: 2527	Code of practice for fixing rain water gutters and down pipe for roof drainage.
IS: 3007	Code of practice for laying of asbestos cement sheets.
IS: 5913	Methods of test for asbestos cement products.
IS: 7178	Technical supply conditions for tapping screw.
IS: 8183	Bonded mineral wool.
IS: 8869	Washers for corrugated sheet roofing.
IS: 12093	Code of practice for laying and fixing of sloped roof covering using plain and corrugated galvanised steel sheets.
IS: 12866	Plastic translucent sheets made from thermosetting polyster resin (glass fibre reinforced).
IS: 14246	Specification for continuously pre-painted galvanised steel sheets and coils.
Fabrication and Erection of Structural Steel Work	
IS: 2016	Specification for plain washers.

	IS: 814	Specification for covered Electrodes for Metal Arc Welding for weld steel.
	IS: 1852	Specification for Rolling and Cutting Tolerances for Hot rolled steel products.
	IS: 3502	Specifications for chequered plate.
	IS: 6911	Specification for stainless steel plate, sheet and strip.
	IS: 3757	Specification for high strength structural bolts
	IS: 6623	Specification for high strength structural nuts.
	IS: 6649	High Tensile friction grip washers.
	IS: 800	Code of practice for use of structural steel in general building construction.
	IS: 816	Code of practice for use of Metal Arc Welding for General Construction.
	IS: 4000	Code of practice for assembly of structural joints using high tensile friction grip fasteners.
	IS: 9595	Code of procedure of Manual Metal Arc Welding of Mild Steel.
	IS: 817	Code of practice for Training and Testing of Metal Arc Welders.
	IS: 1811	Qualifying tests for Metal Arc Welders (engaged in welding structures other than pipes).
	IS: 9178	Criteria for Design of steel bins for storage of Bulk Materials.
	IS: 9006	Recommended Practice for Welding of Clad Steel.
	IS: 7215	Tolerances for fabrication steel structures.
	IS: 12843	Tolerance for erection of structural steel.
	IS: 4353	Recommendations for submerged arc welding of mild steel and low alloy steels.
	SP: 6 (Part 1 to 7)	ISI Hand book for structural Engineers.

IS: 1608	Method of Tensile Testing of Steel products other than sheets, strip, wire and tube.
IS: 1599	Method of Bend Tests for Steel products other than sheet, strip, wire and tube
IS : 228	Methods of chemical Analysis of pig iron, cast iron and plain carbon and low alloy steel.
IS : 2595	Code of Practice for Radio graphic testing.
IS : 1182	Recommended practice for Radiographic Examination of fusion welded butt joints in steel plates.
IS : 3664	Code of practice for Ultra sonic Testing by pulse echo method.
IS : 3613	Acceptance tests for wire flux combination for submerged Arc Welding.
IS : 3658	Code of practice for Liquid penetrant Flaw Detection.
IS : 5334	Code of practice for Magnetic Particle Flaw Detection of Welds.

Plastering and Allied Works

IS : 1635	Code of practice for field slaking of Building lime and preparation of putty.
IS : 1661	Application of cement and cement lime plaster finishes.
IS : 2333	Plaster-of-paris.
IS : 2402	Code of practice for external rendered finishes.
IS : 2547	Gypsum building plaster.
IS : 3150	Hexagonal wire netting for general purpose.

Acid and Alkali Resistant Lining

IS : 158	Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali & heat resisting.
IS : 412	Specification for expanded metal steel sheets for general purpose.

IS : 4441	Code of practice for use of silicate type chemical resistant mortars.
IS : 4443	Code of practice for use of resin type chemical resistant mortars.
IS : 4456	Method of test for chemical resistant tiles. (Part I & II)
IS : 4457	Specification for ceramic unglazed vitreous acid resistant tiles.
IS : 4832	Specification for chemical resistant mortars.
	Part I Silicate type
	Part II Resin type
	Part III Sulphur type
IS : 4860	Specification for acid resistant bricks.
IS : 9510	Specification for bitumasitc, Acid resisting grade.

Water Supply, Drainage and Sanitation

IS : 458	Specification for concrete pipes.
IS : 554	Dimensions for pipe threads, where pressure tight joints are made on thread.
IS : 651	Specification for salt glazed stoneware pipes.
IS : 774	Flushing cisterns for water closets and urinals.
IS : 775	Cast iron brackets and supports for wash basins and sinks.
IS : 778	Copper alloy gate, globe and check valves for water works purposes.
IS : 781	Cast copper alloy screw down bib taps and stop valves for water services.
IS : 782	Caulking lead.
IS : 783	Code of practice for laying of concrete pipes.

IS : 1172	Basic requirements for water supply, drainage and sanitation.
IS : 1230	Cast iron rain water pipes and fittings.
IS : 1239	Mild steel tubes, tubulars and other wrought steel fittings.
IS : 1536	Centrifugally cast (Spun) iron pressure pipes for water, gas and sewage.
IS : 1537	Vertically cast iron pressure pipes for water, gas and sewage.
IS : 1538	Cast iron fittings for pressure pipe for water, gas and sewage.
IS : 1703	Ball valves (horizontal plunger type) including float for water supply purposes.
IS : 1726	Cast iron manhole covers and frames.
IS : 1729	Sand cast iron spigot and socket, soil, water and ventilating pipes, fittings and accessories.
IS : 1742	Code of practice for building drainage.
IS : 1795	Pillar taps for water supply purposes.
IS : 1879	Malleable cast iron pipe fittings.
IS : 2064	Code of practice for selection, installation and maintenance of sanitary appliances.
IS : 2065	Code of practice for water supply in building.
IS : 2326	Automatic flushing cisterns for urinals.
IS : 2470 (Part-I & II)	Code of practice for installation of septic tanks.
IS : 2501	Copper tubes for general engineering purposes.
IS : 2548	Plastic seat and cover for water-closets.
IS : 2556 (Part 1 to 15)	Vitreous sanitary appliances (vitreous china).
IS : 2963	Non-ferrous waste fittings for wash basins and sinks.

IS : 3114	Code of practice for laying of cast iron pipes.
IS : 3311	Waste plug and its accessories for sinks and wash basins.
IS : 3438	Silvered glass mirrors for general purposes.
IS : 3486	Cast iron spigot and socket drain pipes.
IS : 3589	Electrically welded steel pipes for water, gas and sewage (200mm to 2000mm nominal diameter).
IS : 3989	Centrifugally cast (Spun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
IS : 4111 (Part I to IV)	Code of practice for ancillary structure in sewerage system.
IS : 4127	Code of practice for laying of glazed stone-ware pipes.
IS : 4764	Tolerance limits for sewage effluents discharged into inland-surface waters.
IS : 4827	Electro plated coating of nickel and chromium on copper and copper alloys.
IS : 5329	Code of practice for sanitary pipe work above ground for buildings.
IS : 5382	Rubber sealing rings for gas mains, water mains and sewers.
IS : 5822	Code of practice for laying of welded steel pipes for water supply.
IS : 5961	Cast iron grating for drainage purpose.
IS : 7740	Code of practice for road gullies.
IS : 8931	Cast copper alloy fancy bib taps and stop valves for water services.
IS : 8934	Cast copper alloy fancy pillar taps for water services.
IS : 9762	Polyethylene floats for ball valves.
IS : 10446	Glossary of terms for water supply and sanitation.

IS : 10592	Industrial emergency showers, eye and face fountains and combination units.
IS : 12592	Specification for precast concrete manhole covers and frames.
IS : 12701	Rotational moulded polyethylene water storage tanks.
SP: 35	Hand book on water supply and drainage.
-	Manual on Sewerage and sewage treatment (Published by CPH & EEO) As updated.

Doors, Windows and Allied Works

IS : 204	Tower Bolts
Part-I	Ferrous metals.
Part-II	Nonferrous metals.
IS : 208	Door Handles.
IS : 281	Mild steel sliding door bolts for use with padlocks.
IS : 362	Parliament Hinges.
IS : 420	Specification for putty, for use on metal frames.
IS : 1003 Part-I door	Specification for timber panelled and glazed shutters- (Part-I) shutters.
IS : 1038	Steel doors, windows and ventilators.
IS : 1081	Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators.
IS : 1341	Steel butt hinges.
IS : 1361	Steel windows for industrial buildings.
IS : 1823	Floor door stoppers.
IS : 1868	Anodic coatings on Aluminium and its alloys.
IS : 2202 (Part-II)	Specification for wooden flush door shutters (solid core type); particle board face panels and hard board face panels

IS:2209	Mortice locks (vertical type).
IS:2553	Safety glass
IS:2835	Flat transparent sheet glass.
IS:3548	Code of practice for glazing in buildings.
IS:3564	Door closers (Hydraulically regulated).
IS : 3614	Fire check doors; plate, metal covered and rolling type.
IS:4351	Steel door frames.
IS:5187	Flush bolts.
IS:5437	Wired and figured glass
IS:6248	Metal rolling shutters and rolling grills.
IS:6315	Floor springs (hydraulically regulated) for heavy doors.
IS:7196	Hold fasts.
IS:7452	Hot rolled steel sections for doors, windows and ventilators.
IS:10019	Mild steel stays and fasteners.
IS:10451	Steel sliding shutters (top hung type).
IS:10521	Collapsible gates.

R oof Water Proofing and AlliedWorks

IS:1203	Methods of testing tar and bitumen.
IS:1322	Specification for bitumen felts for water proofing and damp proofing.
IS:1346	Code of practice for water proofing of roofs with bitumen felts.
IS:1580	Specification for bituminous compound for water proofing and caulking purposes.

IS:3067	Code of practice for general design details and preparatory work for damp proofing and water proofing of buildings.
IS:3384	Specification for bitumen primer for use in water proofing and damp proofing.

Floor Finishes and Allied Works

IS:1237	Specification for cement concrete flooring tiles.
IS:1443	Code of practice for laying and finishing of cement concrete flooring tiles.
IS:2114	Code of practice for laying in-situ terrazzo floor finish.
IS:2571	Code of practice for laying in-situ cement concrete flooring.
IS:3462	Specification for unbacked flexible PVC flooring.
IS:4971	Recommendations for selection of industrial floor finishes.
IS:5318	Code of practice for laying of flexible PVC sheet and tile flooring.
IS:8042	Specification for white portland cement.
IS:13801	Specification for chequered cement concrete flooring tiles.

Painting and Allied Works

IS:162	Specification for fire resisting silicate type, brushing, for use on wood, colour as required.
IS:1477	Code of practice for painting of ferrous metals in buildings.
Part-I	Pretreatment.
Part-II	Painting.
IS:1650	Specification for colours for building and decorative finishes.
IS:2074	Specification for red oxide-zinc chrome, priming, ready mixed paint air drying.
IS:2338	Code of practice for finishing of wood and wood based materials.
Part-I	Operations and workmanship

Part-II	Schedules
IS:2395	Code of practice for painting concrete, masonry and plaster surfaces.
Part-I	Operations and workmanship.
Part-II	Schedule.
IS:2524	Code of practice for painting of nonferrous metals in buildings.
Part-I	Pretreatment.
Part-II	Painting.
IS:2932	Specification of synthetic enamel paint, exterior, under-coating and finishing.
IS:2933	Specification enamel paint, under coating and finishing.
IS:4759	Code of practice for hot dip zinc coating on structural steel and other allied products.
IS:5410	Specification for cement paint
IS:5411 (Part-I)	Specification for plastic emulsion paint-for exterior use
IS:6278	Code of practices for white washing and colour washing.
IS:10403	Glossary of terms relating to building finishes.
Piling and Foundation	
IS:1080	Code of practice for design and construction of simple spread foundations.
IS:1904	Code of practice for design and construction of foundations in Soils; General Requirements.
IS:2911	Code of practice for designs and construction of Pile foundations (Relevant Parts).
IS:2950 (Part-I)	Code of practice for designs and construction of Raft foundation.
IS:2974 (Part-I TO V)	Code of practice for design and construction of machine foundations.
IS:6403	Code of practice for determination of Allowable Bearing pressure on Shallow foundation.

	IS:8009	Code of practice for calculation of settlement of foundation subjected to symmetrical vertical loads.
	Part-I	Shallow foundations.
	Part-II	Deep foundations.
	IS:12070	Code of practice for design and construction of shallow foundations on rocks.
	DIN:4024	Flexible supporting structures for machines with rotating machines.
	VDI:2056	Criteria for assessing mechanical vibrations of machines.
	VDI:2060	Criteria for assessing rotating imbalances in machines.
	Stop Log and Trash Rack	
	IS:4622	Recommendations for fixed - wheel gates structural design.
	IS:5620	Recommendations for structural design criteria for low head slide gates.
	IS:11388	Recommendations for design of trash rack for intakes.
	IS:11855	General requirements for rubber seals for hydraulic gates.
	Roads	
	IRC:5	Standard specifications and Code of practice for road bridges, section-I general Features of Design.
	IRC:14	Recommended practice of 2cm thick bitumen and tar carpets.
	IRC:16	Specification for priming of base course with bituminous primers.
	IRC:19	Standard specifications and code of practice for water bound macadam.
	IRC:21	Standard specifications and Code of practice for road bridges, section-III - Cement concrete (plain and reinforced).
	IRC:34	Recommendations for road construction in waterlogged areas.
	IRC:36	Recommended practice for the construction of earth embankments for road works.
	IRC:37	Guidelines for the Design of flexible pavements.
	IRC:56	Recommended practice for treatment of embankment slopes for erosion control.
	IRC:73	Geometric design standards for rural (non-urban) highways.
	IRC:86	Geometric Design standards for urban roads in plains.

	IRC:SP:13	Guidelines for the design of small bridges & culverts.
	IRC - Public-	Ministry of Surface Transport (Roads Wing), Specifications
	ation	for road and bridge works.
	IS:73	Specification for paving bitumen
	Loadings	
	IS:875	Code of practice for design loads other than earthquake) for
	(Pt. I to V)	buildings and structures.
	IS:1893	Criteria for earthquake resistant design of structures.
	IS:4091	Code of Practice for design and construction of foundation for transmission line towers & poles.
	IRC:6	Standard specifications & code of practice for road bridges, Section-II Loads and stresses.
	M.O.T.	Deptt. of railways Bridge Rules.
	Safety	
	IS:3696	Safety code for scaffolds and ladders.
	(Part I & II)	
	IS:3764	Safety code for excavation work.
	IS:4081	Safety code for blasting and related drilling operations.
	IS:4130	Safety code for demolition of buildings.
	IS:5121	Safety code for piling and other deep foundations.
	IS:5916	Safety code for construction involving use of hot bituminous materials.
	IS:7205	Safety code for erection on structural steelwork.
	IS:7293	Safety code for working with construction machinery.
	IS:7969	Safety code for handling and storage of building materials
	IS:11769	Guidelines for safe use of products containing asbestos.
	- Indian Explosives Act. 1940 as updated.	
	Architectural design of buildings	
	SP:7	National Building Code of India
	SP:41	Hand book on functional requirements of buildings (other than industrial buildings)

Miscellaneous

IS:802	Code of practice for use of structural steel in
(Relevant parts)	overhead transmission line towers.
IS:803	Code of practice for design, fabrication and erection of vertical mild steel cylindrically welded in storage tanks.
IS:10430	Creteria for design of lined canals and liner for selection of type of lining.
IS:11592	Code of practice for selection and design of belt conveyors.
IS:12867	PVC handrails covers.
CIRIA	Design and construction of buried thin-wall pipes.
Publication	

REFERENCE CODES AND STANDARDS FOR CONTROL AND INSTRUMENTATION

The design, manufacture, inspection, testing & installation of all equipment and system covered under this specification shall conform to the latest editions of codes and standards mentioned below and all other applicable VDE, IEEE, ANSI, ASME, NEC, NEMA, ISA AND Indian Standards and their equivalents.

Temperature Measurements

1. Instrument and apparatus for temperature measurement - ASME PTC 19.3 (1974).
2. Temperature measurement - Thermocouples ANSI MC 96.1 - 1982.
3. Temperature measuremnet by electrical Resistance thermometers - IS:2806.
4. Thermometer - element - Platinum resistance - IS:2848.

Pressure Measurements

1. a) Instruments and apparatus for pressure measurement - ASME PTC 19.2 (1964).
   b) Electonic transmitters BS:6447.
2. Bourdon tube pressure and vacuum gauges - IS:3624 - 1966.
3. Process operated switch devices (Pr. Switch) BS-6134.

Flow Measurements

Instruments and apparatus for flow measurements - ASME PTC 19.5 (1972) Interim supplement, Part-II.

Measurement of fluid flow in closed conduits - BS-1042.

Electronic Measuring Instrument & Control Hardware/ Software

1. Automatic null balancing electrical measuring instruments - ANSI C 39.4 (Rev. 1973): IS:9319.
2. Safety requirements for electrical and electronic measuring and controling instrument - ANSI C 39.5 - 1974.
3. Compatability of analog signals for electronic industrial process instruments - ISA - S 50.1 (1982) ANSI MC 12.1 - 1975.
4. Dynamic response testing of process control instrumentation ISA - S 26 (1968).
5. Surge Withstand Capability (SWC) tests - ANSI C 37.90 a/IEEE-472 or suitable class of IEC-255-4 equivalent to ANSI C37.90a/IEEE-472.
6. Printed circuit boards - IPC TM - 650, IEC 326 C.
7. General requirement and tests for printed wiring boards - IS 7405 (Part-I) 1973.
8. Edge socket connectors - IEC 130-11.
9. Requirements and methods of testing of wire wrap terminations DIN 41611 Part-2.
10. Dimensions of attachment plugs & receptacles - ANSI C 73 - 1973 (Supplement ANSI C 73 a - 1980).
11. Direct acting electrical indicating instrument - IS:1248 - 1968 (R).
12. Standard Digital Interface for Programmable Instrumentation - IEEE-488.2 - 1990.
13. Information Processing Systems - Local Area Networks - Part 2 : Logical Link Control - IEEE-802.2 - 1989.
14. Standard for Local Area Networks : Carrier Sense Multiple Access with Collision Detection - IEEE-802.3 - 1985.
15. Supplements A, B, C and E to Carrier Sense Multiple Access with Collision Detection - IEEE-802.3 - 1988.

16. Standard for Local Area Networks : Token - Passing Bus Access Method - IEEE-802.4 - 1985.

17. Standard for Local Area Networks : Token - Ring Access Method and Physical Layer Specification - IEEE-802.5 - 1985.

18. IEEE Guide to Software Requirements Specifications - IEEE-830 - 1984.

19. Hardware Testing of Digital Process Computers - ISA RP55.1 - 1983.

20. Electromagnetic Susceptibility of Process Control Instrumentation - SAMA PMC 33.1 - 1978.

21. Interface Between the Data Terminal Equipment and Data Circuit - Terminating Equipment Employing Serial Binary Data Interchange - EIA-232-D-1987.

22. Electromagnetic Compatibility for Industrial Process Measurement and Control Equipment, Part 3 : Radiated Electromagnetic Field Requirements - IEC 801-3-1984.

Instrument Switches and Contact

1. Contact rating - AC services NEMA ICS 2 - 1978 (with revision through May 1983), Part - 2-125, A6000.

2. Contact rating - DC services NEMA ICS 2-1978 Part-2 125, N600.

Enclosures

1. Type of Enclosures - NEMA ICS Part - 6 - 1978 (with Rev. 1 4/80) through 110.22 (Type 4 to 13).

2. Racks, panels and associated equipment - EIA : RS - 310 C- 1983 (ANSI C 83.9 - 1972).

3. Protection class for Enclosures, cabinets, control panels & desks - IS:2147 - 1962.

Apparatus, enclosures and installation practices in hazardous area

1. Classification of hazardous area - NFPA 70 - 1984, Article 500.

2. Electrical Instruments in hazardous dust location - ISA - 512.11, 1973.

3. Instrinsically safe apparatus - NFPA 493 1978.

4. Purged and pressurised enclosure for electrical equipment in hazardous location - NFPA 496-1982.

5. Enclosures for Industrial Controls and Systems - NEMA IS 1.1 - 1977.

Sampling System

1. Stainless steel material of tubing and valves for sampling system - ASTMA 296-82, Grade 7 P 316.
2. Submerged helical coil heat exchangers for sample coolers ASTM D11 92-1977.
3. Water and steam in power cycle - ASME PTC 19.11.
4. Standard methods of sampling system - ASTM D 1066-99.

Annunciators

1. Specifications and guides for the use of general purpose annunciators - ISA S 19.1, 1979.
2. Surge withstand capability tests - ANSI C 37.90a - 1989/IEEE-472 or suitable class of IEC 255-4 equivalent to ANSI C37.90a 1989/IEEE-472
3. Damp heat cycling test - IS:2106
4. Specification for Electromagnetic Susceptibility - SAMA DMC 33, 1/78

Protections

1. Relays and relay system associated with electric power apparatus. ANSI C 37.90, 1 - 1989.
2. General requirements & tests for switching devices for control and auxiliary circuits including contactor relays - IS:6875 (Part-I) - 1973.
3. Turbine water damage prevention - ASME TDP-1-1980.
4. Boiler safety interlocks - NFPA Section 85 B - 1984, 85 C - 1991.

UPS System

1. Practices and requirements for semi-conductor power rectifiers - ANSI C 34.2, 1973.
2. Relays and relays system associated with electrical power apparatus - ANSI C 3.90 - 1983.
3. Surge withstand capability test - ANSI C 37.90 1 -1989.
4. Performance testing of UPS - IEC 146.
5. Stationary cells & Batteries Lead Acid type (with tubular positive plates) specification IS-1651-1991.

6. Recommended practice for sizing large lead storage batteries for generating stations & sub-stations - IEEE-485-1985.

7. Printed Circuit Board - IPC TM 650, IEC 326C.

8. General Requirements & tests for printed wiring boards, IS:7405 (Part-I) 1973.

Control Valves

1. Control valve sizing - Compressible & Incompressible fluids - ISA S 75.01-1985.

2. Face to face dimensions of control valves - ANSI B 16.00 - 1973.

3. ISA Hand Book of Control Valves - (ISBN : B: 1047-087664-234-2).

4. Codes for pressure piping - ANSI B 31.1

5. Control Valve leak class - ISA RP 39.6

Process Connection & Piping

1. Codes for pressure piping "power piping" - ANSI B 31.1.

2. Seamless carbon steel pipe ASTM - A - 106.

3. Forged & Rolled Alloy steel pipe flanges, forged fittings and valves and parts - ASTM - A - 182.

4. Material for socket welded fittings - ASTM - A - 105.

5. Seamless ferritic alloy steep pipe - ASTM - A - 335.

6. Pipe fittings of wrought carbon steel and alloy steel - ASTM - A - 234.

7. Composition bronze of ounce metal castings - ASTM - B - 62.

8. Seamless Copper tube, bright annealed - ASTM - B - 168.

9. Seamless copper tube - ASTM - B - 75.

10. Dimension of fittings - ANSI - B - 16.11.

11. Valves flanged and butt welding ends - ANSI - B - 16.34.

Instrument Tubing

1. Seamless carbon steel pipe - ASTM - A 106.

2. Material of socketweld fittings - ASTM - A105.

3. Dimensions of fittings - ANSI - B - 16.11.

4. Code for pressure piping, welding, hydrostatic testing - ANSI B 31.1.

Cables

1. Thermocouples extension wires/cables - ANSI MC 96.1 - 1992.
2. Requirements for copper conductor-Wiring cables for telecommunications & information processing system - VDE:0815.
3. Colour coding of single or multi-pair cables - ICEA - S - 61-402 (third edition) NEMA WCS - 1979 with revisions thorugh 2/83.
4. Insulation & Sheathing compounds for cables : VDE 0207 (Part-4, 5 & 6).
5. Guide design and installation of cable systems in power generating stations (insulation, jacket materials) - IEEE Std. 422-1977.
6. Rules for Testing insulated cables and flexible cables : VVDE - 0472
7. Requirements of vertical flame propagation test - IEEE 383 - 1974 (R 1980)
8. Standard specification for tinned soft or annealed copper wire for electrical purpose - ASTM B-33-81.
9. Oxygen index and temperature index test - ASTM D - 2863.
10. Smoke density measurement test - ASTMD - 2843.
11. Acid gas generation test - IEC - 754 - 1.
12. Swedish Chimney test - SEN - 4241475 (F3).
13. Teflon (FEP) insulation & sheath test - ASTMD - 2116.
14. Thermocouple compensating cables - Testing requirements & sampling plan IS:8784.
15. PVC insulated electric cables for working voltage upto and including 1100 V - IS:1554 (Part-I).

Cable Trays, Conduits

1. Guide for design and installation of cable systems in power generating staiton (Cable trays, support systems, conduits) - IEEE Std. 422, 1977, NEMA VE-1 1979, NFPA 70-1984.
2. -do- Test Standards. NEMA VE-1-1979.
3. Zinc coating "hot dip" on assembled products for galvanising of carbon steel cable trays - ASTMA - 386-78.

Public Address System

1. Specifications for lod speakers - IS:7741 (Part-I, II and III)
2. Code of safety requirement for electric mains operated audio amplifiers - IS:1301
3. Specification for Public Address Amplifiers - IS:10426.
4. Code of practice for outdoor installation of PA system - IS:1982.
5. Code of practice for installation for indoor amplifying and sound distribution system - IS:1881.
6. Basic environmental testing procedures for electronic and electrical items - IS:9000.
7. Characteristics and methods of measurements for sound system equipment - IS:9302
8. Code of practice of electrical wiring installations (System voltage not exceeding 650 volts) - IS:732
9. Rigid steel conduits for electric wiring - IS:9537 (Part-I and II)
10. Fittings for rigid steel conduits for electrical wiring - IS:2667
11. Degree of protection provided by enclosure for low voltage switchgear and control gear - IS:2147.

Vibration Monitoring System

1. API 670 - 1994
2. BS : 4675 Part-2

ANNEXURE-I

MFGR.'s LOGO	MANUFACTURER'S NAME AND ADDRESS	**MANUFACTURING QUALITY PLAN**		PROJECT : PACKAGE : CONTRACT NO. : MAIN-SUPPLIER:
		ITEM : SUB-SYSTEM:	QP NO.: REV.NO.: DATE: PAGE: …. OF….	

SL. NO	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
					M	C / N					M	C	N	
1.	2.	3.	4.	5.	6.		7.	8.	9.	D*	** 10.			11.

		LEGEND: * RECORDS, INDENTIFIED WITH "TICK" (√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION. ** **M:** MANUFACTURER/SUB-SUPPLIER C**:** MAIN SUPPLIER, **N**: NTPC **P:** PERFORM **W**: WITNESS AND **V:** VERIFICATION. AS APPROPRIATE, **CHP:** NTPC SHALL IDENTIFY IN COLUM "N" AS ' W"		DOC. NO.: REV…… CAT…..	
MANUFACTURER/ SUB-SUPPLIER	MAIN-SUPPLIER		FOR NTPC USE		
SIGNATURE				REVIEWED BY	APPROVED BY / APPROVAL SEAL

FORMAT NO.: QS-01-QAI-P-09/F1-R1 **1/1** **ENGG. DIV./QA&I**

ANNEXURE-II

SUPPLIER'S LOGO	SUPPLIER'S NAME AND ADDRESS	FIELD QUALITY PLAN		PROJECT : PACKAGE : CONTRACT NO. : MAIN-SUPPLIER:
		ITEM : SUB-SYSTEM:	QP NO.: REV. NO.: DATE: PAGE: …. OF….	

SL. NO	ACTIVITY AND OPERATION	CHARACTERISTICS / INSTRUMENTS	CLASS OF CHECK #	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		REMARKS
1.	2.	3.	4.	5.	6.	7.	8.	9.	D*	10.

MANUFACTURER/ SUB-SUPPLIER	MAIN-SUPPLIER
SIGNATURE	

LEGEND: * RECORDS, INDENTIFIED WITH "TICK" (√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION.
LEGEND TO BE USED: CLASS # : A = CRITICAL, B=MAJOR, C=MINOR;
'A' SHALL BE WITNESSED BY NTPC FQA, **'B'** SHALL BE WITNESSED BY NTPC ERECTION / CONSTRUCTION DEPTT. AND **'C'** SHALL BE WITNESSED BY MAIN SUPPLIER (A & B CHECK SHALL BE NTPC CHP STAGE)

FOR NTPC USE

DOC. NO.:		REV……
REVIEWED BY	APPROVED BY	APPROVAL SEAL

FORMAT NO.: QS-01-QAI-P-09/F2-R1 **1/1** **ENGG. DIV./QA&I**

ANNEXURE-III

एनटीपीसी NTPC	Project : Stage :: Package : Supplier : Contractor No. :	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB-SUPPLIER APPROVAL SUB-SYSTEM :	DOC. NO.: REV. NO.: DATE : PAGE : OF

S. N.	Item	QP/ Insp. Cat.	QP No.	QP Sub. Schedule	QP approval schedule	Proposed sub-supplier	Place	Sub-suppliers approval status / category	Sub-supplier Details submission schedule	Remarks

LEGENDS

SYSTEM SUPPLIER/SUB-SUPPLIER APPROVAL STATUS CATEGORY (SHALL BE FILLED BY NTPC)

A – **For these items proposed vendor is acceptable to NTPC. To be indicated with letter "A" in the list alongwith the condition of approval, if any.**

DR – **For these items "Detailed required" for NTPC review. To be identified with letter "DR" in the list.**

NOTED – **For these items vendors are approved by Main Supplier and accepted by NTPC without specific vendor approval from NTPC. To be identified with "NOTED.'**

QP/INSPN CATEGORY:

CAT-I **: For these items the Quality Plans are approved by NTPC and the final acceptance will be on physical inspection witness by NTPC.**

CAT-II **: For these items the Quality Plans approved by NTPC. However no physical inspection shall be done by NTPC. The final acceptance by NTPC shall be on the basis review of documents as per approved QP.**

CAT-III **: For these items Main Supplier approves the Quality Plans. The final acceptance by NTPC shall be on the basis certificate of conformance by the main supplier.**

UNITS/WORKS **: Place of manufacturing Place of Main Supplier of multi units/works.**

ANNEXURE-IV

एनटीपीसी NTPC	Project : Stage :: Package : Contractor : Contractor No. :	STATUS OF ITEM REQUIRING QP& SUB-SUPPLIER APPROVAL

DOC. NO.:
REV. NO.:
DATE :
PAGE : OF

S. N.	Item / Service	QP/ Insp. Cat.	QP Sub. Schedule Approval schedule	Date of sub-mission	Date of commt Appl.	Status Code C/II/I	Proposed Sub-suppliers	Place of manufacturing works	Approval Status	Sub-supplier detail submission schedule	Remarks

FORMAT 1/1 Engg. Div. / QA&I

ANNEXURE-V

एनटीपीसी NTPC	Project : Stage : Contractor : Contractor No. : System :	FIELD WELDING SCHEDULE (To be raised by the contractor) Welding Code: ……	DOC. NO.: REV. NO.: DATE : PAGE : OF

Sl. No.	DRG No. for Weld Location and Identification mark	Description of parts to welded	Matl. Spec.	Dimensions		Process of welding	Type of Weld	Electrode filler spec.	WPS. No.	Min. pre-heat	Heat treatment		NDT method/ Quantum	REF		Remarks
											Temp.	Holding time		Spec. No.	ACC Norm Ref.	

NOTES:

SIGNATURE

FORMAT	1/1	**Engg. Div. / QA&I**

S.No	Description of Drgs/Docs	No of Prints	No of CD ROMs/DVDs/Portable Hard Disk
1	Drawings, Data sheets, Design calculations, Purchase specifications and other documents		
	First submission and submission with major changes		
	▪ Layout (A0&A1 sizes)	4	-
	▪ Other Drawings/Documents (A0&A1 sizes)	2	-
	▪ P&ID (All sizes)	4	-
	a) Final drawings/documents (Directly to site)	6	2
	b) "As Built" Drawing/Documents (Directly to site)	6	2
	c) Analysis reports of Equipments / piping /structures components/system employing software packages as detailed in the specifications.	2	2
2	Erection Manual (Directly to site)	4 sets	2
3	Operation & Maintenance manual i) First Submission	1 set	--
	ii) Final Submission (Directly to site)	4 sets	2
4	Plant Hand Book i) First Submission	1	1
5	Commissioning and Performance Test Procedure manual i) First Submission	1 set	--
	ii) Final Submission (Directly to site)	4 sets	2

S.No	Description of Drgs/Docs	No of Prints	No of CD ROMs/DVDs/Portable Hard Disk
6	Performance and Functional Guarantee Test Report i) First Submission	2 sets	–
	ii) Approved Copies (Direct to Site)	4 sets	2
7	Project Completion Report (Directly to site)	6 sets	2
8	QA programme including Organisation for implementation and QA system manual(with revisions)	1	–
9	Vendor details in respect of proposed vendors including contractor's evaluation report.	2	–
10	Manufacturing QPs, Field QPs, Field welding schedules and their reference document like test procedures, WPS, POR etc i) For review/comment	1	–
	ii) Approved final copies of Field QPs, Field welding schedules and their reference document like test procedures, WPS, POR etc (Direct to Site)	4	2
11	Welding Manual, Heat Treatment Manuals, Storage & preservation manuals i) For review/comment	1 set	–
	ii) Approved copies (Direct to Site)	4 sets	2
12	QA Documentation Package for items / equipment manufactured and despatched to site	2 sets	2
13	QA Documentation Package for field activities on equipment/systems at site	2 sets	2

Sl.No	Area	Sub Area	Time of training from date of award	Batch size	Class Room training			Training at Manufacturer works			Training at Operating Plants			Total no. of days
					Content of traning	Location of training	No of days	Content of traning	Location of training	No of days	Content of traning	Location of training	No of days	
1.0	**Steam Generator & Auxiliaries (Mechanical)**													
1.1	Boiler	General famlarisation of supplied boiler	6 months	3	a) General Design, equipment, system and parameter famlarisation of supplied boiler i.e. features, design, operating parameters etc. b) Genaral Layout of boiler & ESP area, basic layout selection criteria, arrangement of pressure part, flue gas duct, coal pipe, bunker, valves, dampers, equipments, piping trestles etc.	Design office of the QSGM	3	1. Manufacturing of pressure parts 2. Welding processes 3. Testing Facilities 4. Product Development in process/ progress 5. Future plan for Technology induction 6. R&D work in progress	Manufacturer's works where the boilers of the subject project is being manufactured.	4	1. General Design, equipment, system and parameter famlarisation of operating boiler (visited) (which preferably should be simillar to supplied boiler) i.e. features, design, operating parameters. The palnt visit should include the following: a) Boiler each floor level walk through b) Visit to all the boiler auxiliaries location. c) Visit to BOP area. 2. Collection of Performance data of the plant	Operating plants in any country including India where same make with similar capacity boilers are under operation.	2	27
1.2	Boiler	Pressure parts	6 months	3	Basic theory/ concept, calculation with illustrative example, Design application, arrangement of following: 1. Thermal design and hydraulic circulation balance 2. Strength Calculation 3. Pressure Part arrangement, coil orientation and basis. 4. Tube metal temperature calculation, criteria for location of thermocouple. 5. Selection Creiteria for soot blower (i.e. location, nos. etc.)	Design office of the QSGM	3							9
1.3	Boiler	Performanc e	6 months	3	Basic concept, calculation of performance data with illustrative example (such as Heat Duty, boiler efficiency, predicted performance, NOX calculation, furnace sizing etc.) of offered boiler and its application to boiler design.	Design office of the QSGM	4							12
1.4	Boiler	Boiler System	6 months	3	a) Basic concept, Sizing calculation of following systems with illustrative examples alongwith details of criteria affecting the sizing calculation : 1. Air & Gas System (duct sizing, air & gas weight calculation, damper & gates sizing etc.) 2. Start up system (Circulation calculation, sizing and input data for SGWC pump etc.) 3. Fuel firing/ Combustion system (Sizing calculation of Pulveriser, feeders, burners, PA & Seal Air Fans etc.) 4. Fuel Oil firing system (Sizing calculation of HFO/ LFO pump, heater, strainers, pressure drop calculation etc.) 5. Draft System (sizing calculation of FD & ID Fans etc.) b) Impact of the above sizing calculation on the overall boiler design/ performance.	Design office of the QSGM	6							18

Sl.No	Area	Sub Area	Time of training from date of award	Batch size	Class Room training			Training at Manufacturer works			Training at Operating Plants			Total no. of days
					Content of traning	Location of training	No of days	Content of traning	Location of training	No of days	Content of traning	Location of training	No of days	
					c) Selection/ optamisation of above system from techno-economics point of view such as start up system: selection criteria for wet mode upto 30% or 40% BMCR flow etc. d) Selection/ Optamisation of various auxilieries/ equipments covered under above systems from techno-economics point of view. Such as type & no. of fans (axial- single/ double stage), APH (Tri sector/ bisector APH), Mills etc.	Design office of the QSGM								
1.5	Boiler	General familarisation of supplied SCR System	6 months	3	General Design, equipment, system and parameter famlarisation of supplied SCR system i.e. features, design, operating parameters etc.	Design office of the SCR System supplier	2	1. Manufacturing of Catalyst 2. Testing Facilities for Catalyst 3. Product Development in process/ progress 4. Future plan for Technology induction 5. R&D work in progress	Manufacturer's works where the SCR Catalysts of the subject project is being manufactured.	1	1. General Design, equipment, system and parameter famlarisation of operating SCR System (visited) (which preferably should be simillar to supplied boiler) i.e. features, design, operating parameters. The plant visit should include the following: a) SCR system each floor level walk through b) Visit to all the SCR system auxiliaries location including Ammonia Dosing system. 2. Collection of Performance data of the plant	Operating plants in any country including India where same make with similar capacity SCR system are under operation.	1	12
1.6	Boiler	Ammonia Dosing System for SCR System	6 months	3	1. Basic theory/ concept. 2. Selection & Sizing calculation of Ammonia dosing system with illustrative examples for Compressors, Storage Tanks, Pumps, vaporisers, Air-NH3 mixers, Glycol-water heaters etc. 3. Familirisation of Safety measures to be ensured for Storage & Using Ammonia. 4. Selection & Sizing Criteria for Safety equipments to be ensured as per Indian Regulations for Ammonia Handling	Design office of the SCR System supplier	2							6
1.7	Boiler	Catalyst Modules for SCR System	6 months	3	1. Basic theory/ concept. 2. Seclection criteria of catalyst 3. Sizing calculation of catalyst & calculation of performance data (i.e. Activity etc.) with illustrative examples	Design office of the SCR System supplier	1							3
1.8	Boiler	FGD System	6 months	3	1. Mass balance, Design, selection and sizing calculations of FGD 2. Training on factors affecting sizing/ efficiency of FGD system, equipments & auxiliaries 3. Materials for FGD & selection 4. Basic concepts, Design and sizing calculations on slurry systems including piping, valves, etc. 5. Layout & model of FGD area, cable & piping trestles etc. 6. Erection strategies, erection procedures. 7. Performance as per applicable code and demonstration tests.	Design office of the FGD System supplier	5	1. Manufacturing process of Absorber and other equipment 2. Welding process 3. Testing facilities 4.Product development in process 5. Future plan for technology induction 6. R&D work in progress.	Manufacturer's works where FGD system equipment of the subject project are being manufactured.	2	1. Familiarization with various system and equipment 2. Performance, data collection analysis and review 3. O&M feed back 4.Operation history of various equipment and system 5. Failure analysis	Operating plants in any country including India where same type with similar capacity FGD system are under operation.	3	30
1.9	Boiler	Buck stay & structure	6 months	3	Basic theory, calculations with illustrative example & Design application of Buck stay & structure design	Design office of the QSGM	2							6
1.10	Boiler	Erection & PG Test	6 months	3	Erection strategies, erection procedures Performance and demonstration tests.	NTPC PMI	2							6

STEAM GENERATOR AUXILIARIES

Sl.No	Area	Sub Area	Time of training from date of award	Batch size	Class Room training			Training at Manufacturer works			Training at Operating Plants			Total no. of days
					Content of traning	Location of training	No of days	Content of traning	Location of training	No of days	Content of traning	Location of training	No of days	
1.11	Boiler	Review & discussion after Plant Visit	6 months	3	1. Analysis and review of collected performance data of the plant visited. 2. Co-relation of the operating plant design, parameter visited wrt to boiler supplied under contract. 3. O&M feedback of the plant 5. Failure analysis: Atleast elaborative case study of one major failure	NTPC PMI	2							6
1.12	Boiler Auxiliaries	Equipments /Auxiliaries	6 months		Selection criteria of auxiliaries (Type, Model, Nos. etc.) based on input data, design features, working & importance of	NTPC PMI			Manufacturer's works where the equipment of the subject project is being manufactured.					
				2	1. Coal pulveriser		2	Visit to manufacturer Works		1				6
				2	2. Fans (ID, FD, PA & Seal Air Fans)		2	Visit to manufacturer Works		1				6
				2	3. Air-preheater		2	Visit to manufacturer Works		1				6
				2	4. Soot Blowers		1							2
				2	5. Dampers & Gates		1							2
				2	6. Valves including safety valves		2							4
				2	7. Feeder		1							2
				2	8. Burner		1							2
				2	9. SG WC pump		1							2
				2	10. Fuel Oil (HFO & LFO) Pumps, Heaters, Strainers etc.		2							4
				2	11. Any other equipment/ auxiliaries not specified above		1							2
Steam Generator & Auxiliaries (Mechanical) TOTAL Mandays		***173***					***128***			***27***			***18***	173

Sl.No	Area	Sub Area	Time of training from date of award	Batch size	Class Room training			Training at Manufacturer works			Training at Operating Plants			Total no. of days
					Content of traning	Location of training	No of days	Content of traning	Location of training	No of days	Content of traning	Location of training	No of days	
2.0	**Steam Generator & Auxiliaries (Power Cycle Piping)**													
2.1	Power Cycle Piping	Stress analysis of piping	6months	4	1. Critical pipe sizing including pressure drop calculation	Design office of the QSGM	2	1. Familarisation of manufacturing/ fabrication/testing of critical piping (including welding techniques & heat treatment methods employed) and norms	Manufacturer's works	2	Familarisation of Power cycle piping & equipment layout	Operating plants in any country including India operating on similar parameters	1	20
2.2	Power Cycle Piping			4	2.Static analysis of critical piping system	Design office of the QSGM	2	2. Familarisation of variable & constant load hanger setting & snubber setting	Manufacturer's works	1				12
2.3	Power Cycle Piping			4	3.Dynamic analysis (safety valve blowing, wind, siesmic & steam hammer) of critical piping	Design office of the QSGM	2							8
2.4	Power Cycle Piping			4	4.Familarisation of Hanger engineering	Design office of the QSGM	1							4
2.5	Power Cycle Piping			4	5.Familarisation of piping vibration analysis & norms	Design office of the QSGM	1							4
POWER CYCLE PIPING TOTAL Mandays		***48***		***4***			***32***			***12***			***4***	48

3.0	**Steam Generator & Auxiliaries (Electrical)**													
3.1	Boiler	Electrical	6 months	3	Integral Actuator	Manufacturer Works	3	1. Design,interface and funtional aspect 2. Familiarisation with various types of actuator	Manufacturer Works	2				15
3.2	Boiler	Electrical	6 months	3	BCW motor	Manufacturer Works	3	1. Design review , manufacturing process, preservation. 2. operation and maintenance,preservation during storage	Manufacturer Works	2				15
3.3	Boiler	Electrical	6 months	3	HT Motor	Manufacturer Works	3	Design review , manufacturing process, storage.	Manufacturer Works	2				15
Electrical TOTAL Mandays		***45***		***3***			***27***			***18***			***0***	45

Sl.No	Area	Sub Area	Time of training from date of award	Batch size	Class Room training			Training at Manufacturer works			Training at Operating Plants			Total no. of days
					Content of traning	Location of training	No of days	Content of traning	Location of training	No of days	Content of traning	Location of training	No of days	
4.0	**Steam Generator & Auxiliaries (Control & Instrumentation)**													
4.1	C&I	SG-DDCMIS-Hardware and Operating System	18 months	4	(a) Hardware & Software organization of the system (b) Basis of selection of H/W memory sizing (c) Operating System features (d) Interface with other system, Openness and inter-operability (e) Upgradability and System testing features	SG-DDCMIS vendor works	2	(a) Hardware & Software organization of the system (b) Basis of selection of H/W memory sizing (c) Operating System features (d) Interface with other system, Openness and inter-operability (e) Upgradability and System testing features	SG-DDCMIS vendor works	2	Operational feedback	Operating plants in any country including India where same make/ model of SG-DDCMIS is in operation.	1.5	22
4.2	C&I	SG-DDCMIS-Human Machine Interface System Engineering & Application Software	18 months	5	(a) Specific system customization (b) Various system modules & interface with OS © Database organisation & development (d) Development of mimics, other applications like calculations, logs, historical storage functionalities & use	SG-DDCMIS vendor works	4	Hands on experience, Testing methodologies	SG-DDCMIS vendor works	2	Operational feedback	Operating plants in any country including India where same make/ model of SG-DDCMIS is in operation.	1	35
4.3	C&I	SG-DDCMIS-(i) Control system hardware (ii) Control system Application Software	18 months	4	(i) (a) Basic design features for system & its Modules, (b) System capabilites & system design techniques (c) Communication with HMI & other systems	SG-DDCMIS vendor works	4	(a) Manufacturing processes with special attention to handling of the modules (b)	SG-DDCMIS vendor works	1	Operational feedback	Operating plants in any country including India where same make/ model of SG-DDCMIS is in	1	24
				4	(ii) (a) Database structure (b) Organization & interface between appplication program & database(c) Application for implementation of Control functions (d) Study of standard algorithms & development of new algorithm	SG-DDCMIS vendor works	3	(ii) (a) System integration & system capabilites testing	SG-DDCMIS vendor works	1				16
4.4	C&I	Boiler Controls: (i) Study of Control loops (ii) Burner Management system	20 months	4	(i) (a) General concept of closed loop controls of the OEM (b) Critical analysis of some important control loops like Boiler Start up control, Feedwater control etc.	Design office of the QSGM	3				Operational feedback	Operating plants in any country including India where same make/ model of SG-DDCMIS is in operation.	1	16
				4	(ii) (a) Hardware logic (b) NFPA-85/ EN-50156/ EN-61508/ En-61511 requirements and other applicable safety standards (c) Flame scanner locations.	Design office of the QSGM	4							16
4.5	C&I	Special SG-related instrumentation (i) Flame Scaneers (ii) Boiler Flame viewing system(iii) Acoustic	24 months	2	(i) (a) Flame scanners: Principle of Operation (b) Suitability for the proposed boiler	Flame scanner vendor's work	1	Manufacturing & testing procedures	Flame scanner vendor's work	1	Operational feedback	Operating plants in any country including India where same make/ model of Flame scanner is in operation.	1	6
				2	(ii) (a) Boiler Flame viewing system: Principle of operation (b) Location (c) Details of software & methods of modification/ customization	Flame camera vendor's work	1				Operational feedback	Operating plants in any country including India where same make/ model of Flame scanner is in operation.	1	4

Sl.No	Area	Sub Area	Time of training from date of award	Batch size	Class Room training			Training at Manufacturer works			Training at Operating Plants			Total no. of days
					Content of traning	Location of training	No of days	Content of traning	Location of training	No of days	Content of traning	Location of training	No of days	
		Pyrometer		2	(iii) (a) Acoustic Pyrometer: Principle of operation (b) Location (c) Details of software & methods of modification/ customization	Acoustic Pyrometer vendor's work	1				Operational feedback	Operating plants in any country including India where same make/ model of Acoustic Pyrometer is in operation.	1	4
4.6	C&I	Electric Power Supply System	22 months	2	System architecture and Component details	Electric power supply system vendor's work	2	Manufacturing/ assebling & testing procedures	Electric power supply system vendor's work	0.5				5
C&I TOTAL Mandays		***148***					***94***			***29***			***25***	148
5.0	**Steam Generator & Auxiliaries (Quality Assurance)**													
5.1	Quality Assurance & Inspection- QA System & Programme	QA System Procedure, Plant Standard	12 months	2	a) Integrated QAManagement System for enhanced reliability of equipments. b) QA system in design, procurement, manufacturing, installation and operation of equipments/ systems. c) QA System for developing and establishing new processes and vendors. d) System of structured documentation of Engg. and test records.	Manufacturer's work	5	1. Appreciation of implementation of QA programmes in various manufacturing, asembly and testing activities. 2. Appreciation of developmental activities for new processes and vendors. 3. System of prequalification of special processes.	Manufacturer's works where the equipment of the subject project is being manufactured.	3	1. operating feedbacks 2. Co-relation of reliability and performance of the equipment with implementation of QA system. 3. Appreciation of the use of structured Engg./ QA documentation during operational phase of plant and during RLA studies of plant.	Operating plants in any country includinh india where same make and similar capacity boilers are under operation.	1	18
5.2	Quality Assurance	SG & Auxiliaries	12 months	5	a) General Design, equipment, system and parameter famlarisation of supplied boiler	PMI	3							15
5.3	Quality Assurance	SG & Auxiliaries (Mechanical)	12 months	4	Pressure parts (Water wall panels, superheaters, Reheaters, headers, economiser, power cycle piping etc.) & Auxiliaries (Fans, Pulversier, APH, Soot blowers, Gates & Dampers, Feeder, SGWC pump etc.) Main design aspect including material of construction and applicable codes/ standards, manufacturing processes, machinery involved, various welding process involved, testing and inspection etc.	Manufacturer's work	3	1. Manufacturing, testing and inspection at various stages of Boiler Pressure parts and Auxiliaries 2. Shop level exposure to these processes with understanding of applicable code/ standard/ parameters involved in manufacturing of main pressure parts and auxiliaries. 3. Various testing and inspection activity in shop for above components.	Manufacturer's works where the equipment of the subject project is being manufactured.	4				28

Sl.No	Area	Sub Area	Time of training from date of award	Batch size	Class Room training			Training at Manufacturer works			Training at Operating Plants			Total no. of days
					Content of traning	Location of training	No of days	Content of traning	Location of training	No of days	Content of traning	Location of training	No of days	
5.4	Quality Assurance	SG & Auxiliaries: Control & instrumentation: Material, construction, Manufacturing, assembly, testing wrt QA aspects, quality procedure and QA system & I	12 months	1	1. Familarisation with control system and instrumentation. 2. QA system for manufacturing of reliable components.	Manufacturer's work	2	1. Manufacturing activities for critical instruments/ items. 2. Implementation of testing programme to ensure reliability.	Manufacturer's works where the equipment of the subject project is being manufactured.	2	Feedback on performance of C&I system	Operating plants in any country includinh india where same make and similar capacity boilers are under operation.	1	5
QA TOTAL Mandays		***66***					***39***			***24***			***3***	66

SUMMARY

1.0	**Steam Generator & Auxiliaries (Mechanical) TOTAL Mandays**	***173***
2.0	**Power Cycle Piping TOTAL Mandays**	***48***
3.0	**Electrical TOTAL Mandays**	***45***
4.0	**C&I TOTAL Mandays**	***148***
5.0	**QA TOTAL Mandays**	***66***
GRAND TOTAL MANDAYS OF TRAINING FOR STEAM GENERATOR & AUXILIARIES		**480**
GRAND TOTAL MANMONTHS OF TRAINING FOR STEAM GENERATOR & AUXILIARIES		**16.0**

PRODUCT	AREAS OF TRAINING REQUIEMENT			
	PRODUCT DESIGN	**Plant Visit**	**Visit to Manufacturer's Work**	**Operation & Maintenance of Plant**
TURBINE GENERATOR AND IT'S INTEGRAL AUXILIARIES	Turbine cycle optimization and turbine performance in off design condition.	Familiarization of power plants of various makes of turbines for super critical units	Manufacturing processes of turbine	
	Rotor design and strength calculation	Collection of data for analysis of availability of turbines	Assembly of turbine	
	Rotor dynamic behavior studies wrt natural frequency, critical speed, vibration etc.	Comparative studies for integral systems of turbine	Testing of turbines	
	Blade profile/root design and blade strength design, blade vibration analysis	O&M history/problems related to turbine	Product development in process	
	Casing & diaphragm design	Failure analysis	Future plan for technology induction	
	Labyrinth seal selection & design for different turbine configurations		R&D work in progress	
	Selection of turbine type (i.e. Tandem vs cross compounding, separate HP/IP vs combined HP/IP, material of construction etc.)			
	Design principle for Up rating/down rating of existing design/ modules for the			

PRODUCT	AREAS OF TRAINING REQUIEMENT			
	PRODUCT DESIGN	**Plant Visit**	**Visit to Manufacturer's Work**	**Operation & Maintenance of Plant**
	specific project. of bearings, load calculation on bearings, bearing oil flow calculation Selection, design and control principle for Turbine governing system Performance calculation Steam path audit Layout principle of various equipment's of TG and its integral system Latest technological advancements			
MANDAYS	**45**	**10**	**10**	
Boiler Feed Pumps	Techno-economic studies for Selection of BFP Configuration and its drive	Familiarization of power plants of various makes of feed pumps for super critical units	Manufacturing process of various components of BFP	
	Criteria for selection of boiler Feed Pump parameters	Data collection of BFP parameters and configuration	Assembly of BFP	
	Rotor design, strength calculation and rotor dynamic behavior studies wrt critical speed, vibration etc	Collection of data for analysis of availability of BFP	Testing, capabilities of BFP at works wrt performance, NPSH, dry run, visual cavitation, axial thrust measurement	

PRODUCT	**AREAS OF TRAINING REQUIEMENT**			
	PRODUCT DESIGN	**Plant Visit**	**Visit to Manufacturer's Work**	**Operation & Maintenance of Plant**
	Impeller design and its hydraulic behavior Role of critical para- meters such as NPSH(R), Suction specific speed, running clearances, speed etc. in design of feed pumps Material selection of BFP components Guiding factors for selection of BFP seals Computation of axial thrust under various flows Performance calculation Transient analysis in pump suction piping wrt NPSH margin Latest technological trends in BFP design	O&M history/problems related to BFP Comparative studies for various types of BFP& its features	Product development in process Future plan for techno-logy induction R&D work in progress	
MANDAYS	**20**	**5**	**10**	
Condenser	Selection of condenser type and its optimization wrt temp rise across condenser, pressure drop in condenser, surface area etc.	Comparative studies of salient features	Manufacturing process of various components of condenser Assembly	

CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS ANNEXURE-VIII			
PRODUCT	**AREAS OF TRAINING REQUIEMENT**			
	PRODUCT DESIGN	**Plant Visit**	**Visit to Manufacturer's Work**	**Operation & Maintenance of Plant**
	Techno economic studies for Selection of condenser tube material and other parts depending on water quality Condenser support selection & design Sizing of condenser w.r.t. super critical units Latest technological trends in condenser arrangement and design Condenser vacuum system design	Collection of data for analysis of availability of Condenser O&M history/problems related to condenser	Testing capability at works Product development in process Future plan for techno-logy induction R&D work in progress	
MANDAYS	**10**	**5**	**5**	
Feed Regenerative Equipment's	Thermal and mechanical design calculation of heaters Basis of selecting horizontal/vertical heaters Selection of TTD and DCAs for various heaters, and their effect on turbine heat rate Configuration of HP heaters (2x50% v/s100% capacity Sizing criteria for De- aerator/Heaters Selection of tube & tube sheet material of heaters	Comparative studies of salient features Analysis of data O&M history/problems related to heaters	Manufacturing process of various components of heaters Assembly Testing capability at works Product development in process Future plan for techno-logy induction R&D work in progress	

PRODUCT	AREAS OF TRAINING REQUIEMENT			
	PRODUCT DESIGN	**Plant Visit**	**Visit to Manufacturer's Work**	**Operation & Maintenance of Plant**
MANDAYS	Latest technological trends in heaters design **15**	**10**	**10**	
3-dimensional CFD modeling	CFD model development and validation of design data for steam turbine, BFP, CEP, condenser, heaters etc.			
MANDAYS	**20**			
CONTROL & INSTRUMENTATION DDCMIS*-Man Machine Interface - Hardware & Operating System	Hardware & Software organization of the system Basis of selection of H/W memory sizing Operating system features, interface with other system, openness & inter-operability Upgradability System testing features Trouble shooting and fault analysis	Operational feedback		
MANDAYS	**15**	**5**		
DDCMIS*-Man Machine Interface System Engineering & Application Software	Specific system customization Various system modules & interface with OS Database organization & development	Operation feedback		

PRODUCT	AREAS OF TRAINING REQUIEMENT			
	PRODUCT DESIGN	**Plant Visit**	**Visit to Manufacturer's Work**	**Operation & Maintenance of Plant**
	Development of mimics Other application like calculations, logs historical storage functionalities & use Trouble shooting and fault analysis			
MANDAYS	**30**	**5**		
DDCMIS* - Control System Hardware	Basic design features for system & its modules System capabilities & system design techniques Communication with MMI & other system	Operation feedback	Manufacturing processes special attention to handling of the modules Maintenance facilities	
MANDAYS	**15**	**3**	**10**	
DDCMIS*- Control system Application Software	Database structure Organisation & interface between application program & database Application for implementation of Control functions Study of standard algorithms & development of new algorithms Trouble shooting and fault analysis	Operation feedback	System integration & System capabilities testing	
MANDAYS	**8**	**2**	**4**	
DDCMIS* - DDCMIS-Control Strategies for TG System:	P&ID and process/System Descriptions of Governing System, Protection System, Automatic Turbine Testing, Oil System, Evacuation System & Generator Auxiliaries, Turbine stress Computation	Yes	Yes	

PRODUCT	**AREAS OF TRAINING REQUIEMENT**			
	PRODUCT DESIGN	**Plant Visit**	**Visit to Manufacturer's Work**	**Operation & Maintenance of Plant**
Process Concepts of Main TG Integral Systems	System, Gland seals, Turbine Start up and Shut-down process, Hot ,cold and Warm modes of Turbine start up etc.			
DDCMIS* - DDCMIS-Control Strategies for TG System: Control Strategies	Measurement System-Redundancy in Measurement for OLCS/CLCS and Protection system. Function Blocks: Introduction and explanation of TG process specific Function block as being implemented in offered Control system. Open Loop Control strategies for ATRS, including turbine Run/Up Shutdown, Auto Synch, Oil System Automation concept, Auto Changer over philosophies, Condenser evacuation system, ATT and Generator Auxiliaries. Close Loop Control strategy-EHTC, Seal/Leak steam Controls, Interfacing of unit Controls Protection-Fail Safe philosophy implementation in turbine protection.	Yes	Yes	
DDCMIS-Control Strategies for TG System: Process Concepts of HP/LP BP Systems	P&ID and process/System Descriptions of HP/LP BP System, Protection System, Oil System, HPBP operations under various modes like start up, Shutdown, Load throw off etc.	Yes	Yes	

PRODUCT	AREAS OF TRAINING REQUIEMENT			
	PRODUCT DESIGN	**Plant Visit**	**Visit to Manufacturer's Work**	**Operation & Maintenance of Plant**
DDCMIS-Control Strategies for TG System: HP/LP BP Systems Control Strategies	Measurement System-Redundancy in Measurement for OLCS/CLCS and Protection system. Function Blocks:- Introduction and explanation of HP/LP process specific Function block as being implemented in offered Control system. Open Loop Control strategies for HPBP operation during various modes of plant operation like Start Up/Shut down and Load Throw Off etc. Close Loop Control strategy- Applicable Control Loops like HP/LP BP Press Control/Position Control, LP BP Spray Controls etc. Interfacing o unit Controls etc. Protection-Fail Safe philosophy implementation in HP/LP BP system	Yes	Yes	
DDCMIS-Control Strategies for TG System: Process Concepts of BFP Drive Turbine/ BFP Systems	P&ID and process/System Descriptions of Drive Turbine Governing System, Protection System, Oil System, Turbine Start up and Shut-down process, Hot, cold and Warm modes of Turbine start up etc.	Yes	Yes	
DDCMIS-Control Strategies for TG System:	Measurement System-Redundancy in Measurement for OLCS/CLCS and Protection system.	Yes	Yes	

CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS ANNEXURE-VIII			
PRODUCT	**AREAS OF TRAINING REQUIEMENT**			
	PRODUCT DESIGN	**Plant Visit**	**Visit to Manufacturer's Work**	**Operation & Maintenance of Plant**
BFP Drive Turbine/ BFP Systems Control Strategies	Function Blocks:- Introduction and explanation of BFP Drive Turbine process specific Function block as being implemented in offered Control system. Open Loop Control strategies for Drive Turbine Start UP/Shutdown, Oil System Automation concept, Auto Changer over philosophies. Close Loop Control strategy-EHTC, Seal/Leak steam Controls, Interfacing of unit Controls Protection-Fail Safe philosophy implementation in Drive turbine protection.			
MANDAYS	**24**	**5**	**4**	
DDCMIS-operator	Use of the system at work + at Site			
MANDAYS	**4**			
Turbo supervisory system : Measurement Concepts	Discussions on various measurement points, Types, Ranges and locations for the offered Turbine	Yes	Yes	
Turbo supervisory system : System Concepts	System implementation of sensors, Monitors, Drivers, Cabling, earthing shielding and grounding, Buffered signals, Technical aspects of sensor selection, Sensor specifications, filter setting, Configuration settings for displacement, Velocity ,acceleration, key phasor and other types of sensors. Diagnostics and	Yes	Yes	

PRODUCT	AREAS OF TRAINING REQUIEMENT			
	PRODUCT DESIGN	**Plant Visit**	**Visit to Manufacturer's Work**	**Operation & Maintenance of Plant**
	trouble shooting features of Sensors, Drivers and Monitors.			
Turbo supervisory system : Analysis Software	1)System Setup-Hardware and Software 2)Case Studies showing utilization of various data displays e.g Bode Plot, Polar Plot, Waterfall Plot, Orbit & Waterfall Plot etc. 3)Tools and methods of finding Machinery faults like oil whirl, Oil whip, Mis-alignment etc	Yes	Yes	
MANDAYS	**8**	**2**	**2**	
Wherever "DDCMIS" is indicated, it will mean TG C&I part of DDCMIS, which is in Contractor's Scope				
(ELECTRICAL) GENERATOR	(a) Design aspects of the following areas - Insulation system - Cooling medium & arrangement - Winding & core support systems b) Design aspects associated auxiliary systems	- Operational feed back - Familarisation with different sub-systems	(a) Manufacturing process for - Core - Winding bars - Assembly (b) Testing facilities	
MANDAYS	**30**	**15**	**15**	
Generator Excitation system including AVR.	Design features of various sub- System Exciter PMG Transformer Controllers & different limiters etc.	- Operational feed back - Familiarisation with various equipment functioning at reference plants	Manufacturing process & testing facilities for various equipment of excitation system	

PRODUCT	**AREAS OF TRAINING REQUIEMENT**			
	PRODUCT DESIGN	**Plant Visit**	**Visit to Manufacturer's Work**	**Operation & Maintenance of Plant**
	PSS & associated system studies	functioning at referplants		
MANDAYS	**30**	**15**	**15**	
Integral Actuators	a) Basic design philosophy of integral actuator b) Design aspects of wiring diagram c) Type and range of application of integral actuators d) Operation and selection of integral actuator to various type of loads Methods of fault diagnose system.		Manufacturing process & testing facilities for various equipment of actuators	
MANDAYS	**2**	**1**	**1**	
MDBFP motor	Design criteria for the stator core and winding rotor core and winding, insulation systems and cooling arrangement. Study of forces and vibration. Diagnostic and testing of large Electrical machines	Operational Feedback	Manufacturing process and testing facilities.	
MANDAYS	**14**	**4**	**10**	

ANNEXURE-IX

Area	Topics	MANDAYS
DDCMIS-Man Machine Interface - Hardware & Operating System	• Hardware & Software organization of the system • Basis of selection of H/W memory sizing • Operating system features, interface with other system, openness & inter-operability • Upgradeability • System testing features	**20**
	• Trouble shooting and fault analysis.	
DDCMIS-Man Machine Interface System Engineering & Application Software	• Specific system customisation • Various system modules & interface with OS • Database organisation & development • Development of mimics • Other application like calculations, logs historical storage functionalities & use • Trouble shooting and fault analysis.	**40**
DDCMIS - Control System Hardware and Control system Application Software	• Basic design features for system & its modules • Manufacturing processes with special attention to handling of the modules Maintenance facilities	**50**
	• System capabilities & system design techniques • System integration & System capabilities testing	
	• Communication with MMI & other system	
	• Database structure Organisation & inter- face between application program & database	

	• Application for implementation of Control functions • Study of standard algorithms & development of new algorithms	
	• Trouble shooting and fault analysis.	
DDCMIS-Operator Training	• Use of the system at Works + at Site	**20 + 100**
DDCMIS-Specialized Network security training	• To be finalized during detailed engineering.	**15**
UPS system	• Theory & design features Manufacturing/assembly process • Testing methodology	**5**
	• Trouble shooting and fault analysis.	
24 V DC system	• Theory & design features Manufacturing/assembly process • Testing methodology • Trouble shooting and fault analysis.	**5**
SWAS	• Theory & design features • Trouble shooting and fault analysis	**5**
PA System	• Theory & design features • Trouble shooting and fault analysis	**4**
CCTV System	• Theory & design features • Trouble shooting and fault analysis	**4**

QA SYSTEM & PROGRAMME	• Integrated QA Management system for enhanced reliability of equipments. • QA system in design, procurement, manufacturing, installation and operation of the equipments/ systems. • QA system for developing and establishing new processes and vendors. • System of structured documentation of Engg and test records. • Appreciation of implementation of QA Programme in various manufacturing, assembly and testing activities. • Appreciation of develop-mental activities for new processes and vendors. • System of pre-qualification of special processes.	**10**
Controls & Instruments	• Familiarization with control system and instrumentation • QA System for manufacture of reliable components. Manufacturing activities for critical instruments/items. • Implementation of testing programme to ensure reliability.	**10**
Note	**One week shall constitute of five (5) man days.**	

PRODUCT	AREAS OF TRAINING REQUIEMENT			
	PRODUCT DESIGN	**Plant Visit**	**Visit to Manufacturer's Work**	**Operation & Maintenance of Plant**
GIS			Training on GIS equipments including system description basic design and engineering. Quality assurance concepts and Erection and operational aspects for the offered equipments. Concepts and operational aspects for the offered equipments	Training on Operation, Maintenance,, site testing & troubleshooting of GIS.
MANDAYS			**40**	**30**
Substation Automation System				Training for site personnel for operation, maintenance & troubleshooting of total system for 5 working days at NTPC site.
MV and LT Switchgear : Numerical relays & Switchgear SCADA system	Numerical relay engineering and associated training for relay software and O&M SCADA system design, engineering and associated training for SCADA and O&M			
MANDAYS	**60 (Total) inclusive of visit to manufacturer's site)**			

ANNEXURE - XI

Area	Topics	MANDAYS
UF Membranes	**Product design** - Basic design features - Theory & principle of operation - Latest technological trends in Ultrafiltration membranes and design **Plant Visit** - Operational feedback - O&M history/problems related to UF membranes **Visit to Manufacturer's Work** - Manufacturing process of UF membranes and equipments - Testing facilities **Operation & Maintenance of Plant** - Trouble shooting and fault analysis - Familiarization of special maintenance techniques - Special tool and tackles familiarization	**7**

RO membranes	**Product design** - Basic design features - Theory & principle of operation - Latest technological trends in RO membranes and design **Plant Visit** - Operational feedback - O&M history/problems related to RO membranes **Visit to Manufacturer's Work** - Manufacturing process of RO membranes and equipments - Testing facilities **Operation & Maintenance of Plant** - Trouble shooting and fault analysis - Familiarization of special maintenance techniques - Special tool and tackles familiarization	**7**
Zero Liquid Discharge (ZLD)	**System Design** - Plant water optimization and Scheme to achieve the ZLD - Basic design features - Latest technological trends for ZLD in Thermal Power Plant **Plant Visit** - Operational feedback	**5**
Note	**One week shall constitute of five (5) man days.**	

Annexure-XII

TRAINING REQUIREMENTS FOR SIMULATOR

In addition to the other stipulations in the bidding documents regarding training of Employer's personnel, the following shall also be covered:

(i) The scope of service under training of Employer's Engineers shall necessarily include, training in the areas of:

(a) Design, engineering and Quality Assurance.

(b) Operation & maintenance.

Arrangement for the trainees to get trained at the Works of the Contractor's, Works of their sub-vendors and at the plants of similar type and comparable size, operating elsewhere shall be made by the Contractor.

(ii) The training shall enable the O&M personnel to individually take responsibility of operating & maintaining the respective systems to ensure sustained guaranteed performance of the equipment and availability of the systems offered. The design & engineering personnel of the Employer shall be familiarized with the design philosophy adopted & practices followed by the Contractor or Sub-Contractor's Engineers for design engineering and shall be given special training in the shops, where the equipment will be manufactured and/or in their collaborator's works and where possible, in any other plant where equipment manufactured by the Contractor or his collaborator is under installation operation, or testing to enable these personnel to become familiar with the equipment being furnished by the Contractor. The training requirements of Employer's Engineering and O&M personnel are as below:

Area	Topics	MANDAYS
Simulator & Human Machine Interface – Hardware and Operating System	• Hardware & software organization of the system	**90**
	• Basis of selection of HW memory sizing	
	• Operating system features, interface with other system, openness & inter operability & upgradability System Testing features	
	• Trouble shooting & Fault Analysis	

Simulator System Engineering (Simulator Kernel and Interface) & Application Software (Process and C&I Modelling)	• Overview of Simulator • Starting up and Shutting down of the simulator • Details of Simulator hardware & software • Interaction between Simulator Models and controls & Instructor Station operations • Manipulation of Simulator parameters and data.	**150**
	• Details of Plant Modelling & C&I Modelling simulation software	
	• Details of Simulator and DCS interface	
	• Backup and Restore procedures	
	• Details of I/O system	
	• Fault finding of simulator hardware & Software diagnostic procedures	
	• Simulator maintenance procedures	
Human Machine Interface System Engineering & Application Software	• Specific system customisation	**90**
	• Various system modules & interface with OS	
	• Database organisation & development • Development of mimics • Other application like calculations, logs historical storage functionalities & use • Trouble shooting and fault analysis.	
Instructor Training	Use of the system including • Interaction between Simulator Models and controls • Instructor Station operations	**150**
	• Communication with MMI & other system	
	• Database structure Organisation & inter-face between application program & database	

	• Application for implementation of Control functions • Study of standard algorithms & development of new algorithms	
	• Trouble shooting and fault analysis.	
UPS system	• Theory & design features manufacturing/assembly process • Testing methodology	**10**
	• Trouble shooting and fault analysis.	
Note	**Note One week shall constitute of five (5) man days.**	

GENERAL TECHNICAL REQUIREMENT OF WATER TREATMENT SYSTEM/PLANT

EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-1 (3x800 MW)	TECHNICAL SPECIFICATION SECTION-VI PART-A BID DOC NO: CS-9585-001-2

MECHANICAL SYSTEMS & E□UIPMENT

1.00.00 GENERAL

1.01.00 The scope of the water Treatment plant includes Design, Engineering, Supply, Construction, Erection, Testing & Commissioning of complete Water treatment System including all Civil, Electrical and Control & Instrumentation works. Broad scope of work described below shall be read in conjunction with the Data Sheets, Electrical works and Control & Instrumentation works and Civil Works, various subsections of Part-B of this Technical Specification and relevant Tender drawings. The broad scope of Water Treatment Plant includes but not limited to the following systems and equipment.

1.02.00 The analysis of Raw water to be adopted for design of water treatment plant is enclosed elsewhere in the technical specification. Bidder to decide the design filter water analysis for RO/DM based on the Pre-treatment.

1.01.00 WATER PRE-TREATMENT PLANT

1.01.01 PT- ACW S□□□□

a) Raw water pipe (CS) up to the aerator through a set of Control Valve & Isolation Valves for Control Valves.

b) One (1) number Aerator and one (1) number stilling chamber of RCC Construction of required capacity along with isolation gates at the inlet to the inlet channels for PT-ACW system clarifier.

c) Two (2) numbers of inlet channels with flow measuring element in each channel (parshall flume) of RCC Construction.

d) One (1) number bypass channel of RCC Construction to by-pass clarifier(s) with required isolation gate(s)

e) Two (2) numbers of reactor type clarifiers of RCC Construction each of required capacity including associated equipment and drives for PT-ACW system.

f) One (1) number Clarified Water Storage Tank/Clarified water distribution chamber of RCC Construction of required capacity/sizes with required isolation Valves.

g) Outlet channels of RCC Construction from Clarifiers up to the Clarified Water Storage Tank/Clarified water distribution chamber.

h) Interconnection between the clarified water outlet channel and outlet channel of PT-DM System.

1.01.02 **PT-P□□□□□ W□□r S□□□□**

a) Outlet channel of RCC Construction from Clarifiers header up to the Gravity filters of Potable Water System

b) Two (2) numbers of Gravity Filters (Potable Water System) of RCC Construction each of required capacity with all accessories as described elsewhere, interconnecting piping, valves etc.

c) One (1) number filtered water reservoir (in twin sections located below the filters) of RCC Construction of each of required capacity, filtered water sump and common filtered water pump house for PT–Potable water & PT-DM systems.

d) Two (2) numbers of Potable water pumps (Colony), its drives, associated suction pipes from filtered water sump, isolation valves, pump(s) discharge pipes(CS), non-return valves & isolation valves at the discharge etc.

e) Two (2) numbers of Potable water pumps (Plant), its drives, associated suction pipes from filtered water sump, isolation valves, pump(s) discharge pipes(CS), non-return valves & isolation valves at the discharge etc.

f) Three (3) number of air blowers of oil free type of required capacity, its drives and associated accessories, air (Galvanised CS) piping from blowers to each section of the filter for air scouring of filters during backwash operation.

g) One (1) number electrically operated monorail hoist (common for both PT-DM & PT-Potable System) of required capacity for handling all the pumps, blowers, drives etc.

h) Required interconnecting air (Galvanised CS) piping, valves etc from the blowers to each Gravity filter for air scouring of filters during backwash operation.

i) Pipe & Valves to facilitate future expansion.

1.01.03 **PT- DM S□□□□□**

a) Raw water pipe (CS) up to the aerator through a set of Control Valve & Isolation Valves for Control Valves.

b) One (1) number Aerator and one (1) number stilling chamber of RCC Construction of required capacity along with isolating gates at the inlet to the inlet channels for PT- DM system clarifier.

c) One (1) number inlet channel of RCC Construction with flow measuring element in each channel (parshall flume).

d) One (1) number bypass channel of RCC Construction to by-pass clarifier(s) with required isolation gate(s).

e) One (1) number reactor type clarifier of RCC Construction of required capacity including associated equipment and drives for PT-DM system.

f) Outlet channel of RCC Construction from Clarifier up to the Gravity filters of PT-DM System

g) Two (2) numbers of Gravity Filters (PT-DM System) of RCC Construction each of required capacity with all accessories as described elsewhere, interconnecting piping, valves etc.

h) One (1) number filtered water reservoir (in twin sections located below the filters) of RCC Construction of each of capacity, filtered water sump and filtered water pump house.

i) Three (3) numbers of air blowers of oil free type of required capacity, its drives and associated accessories, air (Galvanised CS) piping from blowers to each section of the filter for air scouring of filters during backwash operation.

j) ~~Required numbers of Filtered water Transfer pumps & drives for feeding to DM plant etc~~.

k) Required interconnecting air (Galvanised CS) piping, valves etc. from the blowers to each Gravity filter for air scouring of filters during backwash operation.

l) Pipe & Valves to facilitate future expansion.

1.01.04 **C□□□ □□□□H□□□□ E□□□□ □□□**

a) Two (2) numbers of electrically operated monorail hoists for transporting the chemicals from the ground floor to the respective preparation tanks and required number of weighing scales.

b) Lime preparation & dosing system consisting of required number of RCC lime slaking tanks, RCC lime solution preparation tanks, agitators, lime slurry transfer pumps, lime solution dosing pumps complete with all necessary piping, fittings, feed piping, water supply piping, overflow and drain piping, sampling connections etc.

c) Alum Solution preparation & dosing system consisting of required number of RCC Alum solution preparation tanks, agitators, alum solution dosing pumps complete with all necessary piping, fittings, feed piping, water supply piping, overflow and drain piping, sampling connections etc.

d) $FeCl_3$ preparation & dosing system consisting of required number of preparation tanks, agitators, dosing pumps complete with all necessary piping, fittings, feed piping, water supply piping, overflow and drain piping, sampling connections etc.

e) PE dosing system consisting of required number of tanks, agitators, dosing pumps complete with all necessary piping, fittings, feed piping, water supply piping, overflow and drain piping, sampling connections etc. (in case of PT-RO)

f) PAC dosing system consisting of required number of tanks, agitators, dosing pumps complete with all necessary piping, fittings, feed piping, water supply piping, overflow and drain piping, sampling connections etc.

g) One (1) number RCC overhead filtered water storage tank of required capacity, on top of chemical house with water supply line from the discharge of filtered water pumps, associated valves, piping, fittings etc.

h) Mechanical Ventilation system for complete chemical house building covering chemical storage area, chemical preparation area, toilets etc.

1.02.00 **CHLORINATION PLANT**

ACW C□□□r□□□□□□□

a) Required numbers of Chlorine tonners, Evaporators, chlorinators, chlorinators, ejectors, Chlorine water booster pumps its drives, required piping, valves etc. from pumps up to CT basin of ACW pump house, diffusers for dosing chlorine, associated valves etc.

b) Required Safety and supervisory Equipment such as Gas masks, Chlorine leak detectors and emergency kits.

c) Required numbers of hoist(s) for handling Chlorine ton-containers in the chlorination plant building.

d) Chlorine Leak absorption system (each for ACW & PT Systems) consisting of required number of hoods over the tonne containers, ducting arrangement, absorption tank, alkali recirculation pumps, blowers, piping, valves, chlorine leak detectors etc. as detailed out in Data sheets and Part-B of technical specification.

e) Required Mechanical Ventilation system for complete building.

PT C□□□r□□□□□□□

a) Required numbers of Chlorine tonners, chlorinators, ejectors, Chlorine water booster pumps, its drives, required piping, valves etc. from pumps up to the aerators & stilling chambers of each clarifier, diffusers for dosing chlorine, associated valves, Safety and supervisory Equipment such as Gas masks, Chlorine leak detectors and emergency kits etc. Capacity of each of the equipment/items shall be as mentioned in the data sheets.

1.03.00 **LI□UID EFFLUENT TREATMENT SYSTEM**

1.03.01 **PT- P□□□□C□□r□□□r S□□d□□ D□□□□□□□S□□□□□**

a) One (1) number RCC sludge pit (2 sections) to collect sludge from all the clarifiers of PT-ACW & Potable system, PT-DM system & Tube settlers/Lamella clarifiers of required capacity, sludge piping from clarifiers up to the pit, associated valves etc.

b) Sludge disposal pumps of required capacity, its drives, associated valves, piping etc.

c) Air blowers of oil free type of required capacity, its drives and associated accessories, air (Galvanised CS) piping from blowers to each section of the sludge pit for air scouring of sludge.

d) One (1) number of Sludge thickener of required capacity, pumps, associated valves, piping etc.

e) Centrifuge/filter press (2x50%) of required capacity, pumps, associated valves, piping etc.

1.03.02 **F□□□r B□□□ W□□□ W□□□ D□□□□□□S□□□□**

a) One (1) number RCC Filter backwash waste collection pit of required capacity to collect the backwash water from both PT-DM & PT-Potable gravity filters, back wash waste water piping from filters up to the pit, associated valves etc.

b) Required number of backwash water pumps, its drives, associated piping and valves from the above pumps to stilling chamber of PT-DM and PT-CW system.

1.03.03 **W□□□□ S□r□□□□ W□□r Tr□□□□ □□□S□□□□**

a) One (1) number RCC waste service water sump (WSWS) (2 sections) for collection of various waste water of the plant.

b) Facility to collect free oil from these sumps to a MS oil drum of 200 litre capacity with the help of Drum type (2 Nos.) oil skimmers, Centrifuge (1 no.) of required capacity.

c) Required number of Waste service water transfer pumps to transfer the waste service water from the sump to the tube settlers/lamella clarifiers, its drives associated piping (CS) & valves etc.

d) Two (2) numbers tube settlers/lamella clarifiers of RCC Construction along with RCC flash mixers and RCC flocculation chambers. Both the flash mixers and flocculation chambers shall be provided with agitators (SS-316 construction).

e) The capacity of waste service water sump and tube settlers/lamella clarifiers shall also meet the requirement of supernatant flow from the clarifier of coal slurry settling pond.

f) One (1) number of RCC treated water tank for collection of treated water. Required number of Treated water pumps of capacity required to transfer the treated service water, its drives, associated piping (CS) & valves etc.

g) Sludge Pipeline (Cast Iron) with associated valves from the tube settlers/ lamella clarifiers by gravity flow up to the common sludge pit.

1.03.04 **C□□□H□□d□□□ P□□□□R□□-O□□W□□□r Tr□□□□ □□□S□□□□□**

a) Inlet connection channel from drain in Coal Stockyard area up to the Coal Slurry Settling (CSSP) Pond to transfer waste water laden with coal dust to the CSSP.

b) Required number of Coal Slurry Settling (CSSP) Ponds of RCC Construction each of size/capacity as mentioned in Data sheets/ tender drawings.

c) Required number of Coagulant-aid tanks of Mild steel rubber lined construction.

d) One (1) number decanted water sump of RCC Construction (2 sections) to receive decanted water from above settling ponds of required size/capacity and discharge channel from the CSSP to decanted water sump as well as to the plant drain.

e) Required number of Coal Decanted Water Pumps and Clarified feed pumps (CSSP area) of required capacity, its drives, associated piping (CS), Valves etc.

f) Decanted water channel of RCC Construction from CSSP to the drain with gates etc.

g) Two (2) numbers portable submersible type pumps for draining the water from the CSSP, with hose pipes etc.

h) One (1) number stilling chamber, two (2) numbers of inlet chambers and two (2) numbers of reactor clarifiers of RCC construction, RCC channels, distribution chamber etc. of required capacity to receive excess storm water from settling ponds, required number of pumps, piping, valves etc. to discharge treated supernatant water to storm water drain. Necessary lime dosing facility for neutralization like preparation tanks, dosing tanks, pumps (2x100%), piping etc.

i) Lime preparation & dosing system consisting of required number of RCC lime slaking tanks, RCC lime solution preparation tanks, agitators, lime slurry transfer pumps, lime solution dosing pumps complete with all necessary piping, fittings, feed piping, water supply piping, overflow and drain piping, sampling connections etc.

j) Alum Solution preparation & dosing system consisting of required number of RCC Alum solution preparation tanks, agitators, alum solution dosing pumps complete with all necessary piping, fittings, feed piping, water supply piping, overflow and drain piping, sampling connections etc.

k) Suitable synthetic flocculent dosing shall also be provided to increase the settling rate suspended solids. Flocculent preparation & dosing system consisting of required number of preparation tanks, agitators, dosing pumps complete with all necessary piping, fittings, feed piping, water supply piping, overflow and drain piping, sampling connections etc. shall be provided.

l) The sludge removed from underflow of the clarifier shall be dewatered using the Filter press for dried coal particles to be reused. Required numbers of filter presses, necessary pumps, piping, valves etc. shall be provided.

1.03.05 **C□□r□□M□□□r□□ B□□□**

a) One (1) number (twin section) Central Monitoring (CMB) Basin of RCC Construction of required capacity to receive treated water from tube settlers/ lamella clarifiers, excess ACW system blow down water, neutralised effluent of DM plant, any other treated plant effluents etc.

b) Required number of waste water RO effluent pumps of required capacity, its drives, associated valves, piping etc. to pump the plant waste water to the stilling chamber for waste water RO plant.

1.03.06 Any other equipment required for the completeness of the plant as per system requirement and specification requirements as specified in Part-B.

2.00.00 DEMINERALISATION (DM) PLANT

A) OPTION □1 (ION EXCHANGE BASED DM PLANT)

a) Required number of Filtered Water transfer Pumps of required capacity, its drives & associated piping from filtered water pump house (in PT area) to DM Plant.

b) Two (2) numbers of Activated carbon filters with all accessories.

c) Two (2) numbers of Cation exchangers units (both weak and strong) with all accessories.

d) Two (2) numbers of Degasser system comprising of Degasser Tower, storage tank, Air Blowers [two (2) numbers per degasser tower] & its drives and required number of Degassed water transfer pumps & its drives with all accessories.

e) Two (2) numbers of Anion exchanger units (both weak and strong) with all accessories.

f) Two (2) numbers of Mixed bed unit along with Two (2) numbers air blowers with its drives and all accessories.

g) Complete Hydrochloric acid handling, measuring tanks and dosage system.

h) Complete Alkali handling, storage and dosage system

i) Required numbers of safety shower units and adequate number of Eye-fountains to protect against any chemical hazard.

j) Three (3) numbers of DM water storage tanks with all accessories.

k) Required numbers of DM water pumps for regeneration system and its drives.

l) Neutralizing waste disposal system - All DM plant Effluent drains (except backwash water from AC filters, rinse waste water and fast/final rinse waste water of Ion-Exchangers units) shall be connected to the Neutralisation Pit. Neutralised waste shall be pumped to central monitoring basin.

m) Backwash water from AC filters, rinse waste water and fast/final rinse waste water of Ion-Exchangers units shall be connected to the backwash sump and same shall be led into the inlet channel of PT-DM clarifier of Water Pretreatment Plant. UF back wash water shall also be led to this back wash pit.

n) First fill of filter media for AC filters.

o) First fill of resins for all Ion Exchange units.

p) 25 NB Stainless steel DM water line from Mixed Bed headers to DM plant lab.

q) Interconnecting piping, valves, fittings and accessories including Pre Cast RCC pipes at road crossing as required.

r) Supply and application of final painting to all the equipment, piping & accessories.

s) All approach ladders and operation/maintenance platforms, handrails as required for various equipment, valves and instruments, support trestles, bridges, brackets, bolts, nuts, clamps etc. for the associated piping.

t) Suitable MS Epoxy Painted elevated Access Platform to be provided for internal inspection of all the AC Filters and Ion Exchanger vessels.

u) Required numbers of DM water makeup pumps and drives & associated valves and piping etc.

v) Required numbers of Boiler Fill pumps and drives & associated Valves and piping etc.

w) Required numbers of condensate transfer pumps and drives & associated Valves and piping etc.

x) Brine Solution Preparation Tank and Brine transfer pumps, piping and valves.

y) Provision of hot water supply to the ACF units from the hot water tank shall be made for rejuvenation of activated carbon and the DM regeneration pumps to be sized considering above requirement in addition to required for regeneration.

B) OPTION-2 (UF □ RO□MB BASED DM PLANT)

1. ULTRAFILTRATION (UF) SYSTEM

a) Required numbers of UF (Filter Water Supply Pumps) of required capacity with electrical motor drives, suction & discharge pipe header, valves and all accessories.

b) Interconnecting Pipe from filtered water transfer pumps to filtration system.

c) Interconnecting piping, Valves etc. between filtration system and suction header of RO plant.

d) Required numbers of Basket strainers, Ultra filtration system membranes (UF skids) (2x50%) (Pressurised type) along with necessary valves, piping, fittings etc.

e) Required numbers of UF backwash pumps along with flushing tanks and pumps, CEB tank, chemical dosing system, required storage tank etc. CIP system (as applicable) shall be provided as per manufacturer's standard.

f) Piping from Gravity filter outlet to Ultra filtration system, outlet piping from UF to UF permeate storage tank, backwash water supply from UF permeate storage tank to UF membranes, recirculation pipe from backwash waste of Gravity filters & UF to backwash pit and further pumping to stilling chamber of PT-DM clarifier, associated valves, instruments, controls etc.

g) UF streams shall be pressurized type.

h) Required numbers of UF permeate water storage Tanks of required capacity/sizes with required isolation Valves.

i) Required numbers of UF permeate transfer pumps of required capacity, its drives, associated valves, piping etc.

j) Piping from UF system up to the backwash pit, associated valves etc.,

k) Required platform, ladders etc. to facilitate approach to various tanks, manholes/hand-holes, sight-glass, operation & maintenance of valves, instruments etc. shall be provided.

l) Piping from the discharge header of above backwash water disposal pumps up to the stilling chamber of PT-DM clarifier.

2. MICRON CARTIRDGE FILTERS

b) Required numbers of Micron Cartridge Filter (MCF) shall be sized for rated capacity of UF permeate transfer pumps.

c) The design pressure of vessel shall be at least 115% of sum of shut-off head of UF permeate transfer pumps and suction head available.

3. RO SYSTEM

a) Required numbers of High Pressure (HP)-RO feed pumps with electric motor drives, suction header from discharge header of Cartridge filters & discharge pipe header, valves, accessories, associated piping, valves, fitting etc.

b) Three (3) (3x50%) (2W+1S) numbers of RO Streams/trains module rack assemblies, sampling facilities and automatically operated reject control valves, piping, fittings etc.

c) Complete system for chemical cleaning and Flushing system comprising the necessary tanks and pumps for RO trains/streams. The effluent of RO chemical cleaning shall be led to the sludge pit.

d) Complete degassifier system for removal of CO_2 in permeate water from RO units, consisting of one degasser towers of required capacity with spray nozzles, mist eliminators, packing, packing support structures, operating platforms, ladders, gratings etc.

e) Required number of RO permeate water storage tanks of required capacity and required numbers of Degasser Blowers for Degasser.

f) Required number of Degassed water/RO permeate transfer pumps of required capacity with electrical motor drives, suction & discharge pipe, valves, accessories etc.

g) Three (3) numbers of Mixed bed unit along with two (2) numbers air blowers with its drives and all accessories.

h) Complete Hydrochloric acid handling, measuring tanks and dosage system.

i) Complete Alkali handling, storage and dosage system.

j) Required number of safety shower units and adequate number of Eye-fountains to protect against any chemical hazard.

k) Neutralizing waste disposal system - All DM plant Effluent drains (except backwash water from AC filters, rinse waste water and fast/final rinse waste water of Ion-Exchangers units) shall be connected to the Neutralisation Pit. Neutralised waste shall be pumped up to Central monitoring basin.

l) Backwash water from AC filters, rinse waste water and fast/final rinse waste water of Ion-Exchangers units shall be connected to the backwash sump and same shall be led into the inlet channel of PT-DM clarifier.

m) First fill of filter media for AC filters & First fill of resins for all Ion Exchange units

n) 25 NB Stainless steel DM water line from Mixed Bed headers to DM plant lab.

o) Approach ladders and operation/maintenance platforms, handrails as required for various equipment, valves and instruments. Construction of support trestles, bridges, brackets, bolts, nuts, clamps etc. for the associated piping are under bidder's scope.

p) Suitable MS Epoxy painted elevated access platform to be provided for internal inspection of all the AC Filters and Ion Exchanger vessels

q) Provision of hot water supply to the ACF units from the hot water tank shall be made for rejuvenation of activated carbon and the DM regeneration

pumps to be sized considering above requirement in addition to that required for regeneration.

r) Three (3) numbers of DM water storage tanks with all accessories.

s) Required number of DM water pumps for regeneration system and its drives.

t) Required number of DM water makeup pumps and drives & associated Valves and piping etc.

u) Required number of Boiler Fill pumps and drives & associated Valves and piping etc.

v) Required number of Condensate transfer pumps and drives & associated Valves and piping etc.

w) Supply of Antiscalant and Antioxidant applicable as offered for RO skids for a period of one (1) year from the date of successful commissioning of the proposed water treatment plant.

x) RO Reject water piping from RO trains up to CHP tank. The effluent of RO chemical cleaning shall be led to the sludge pit.

y) Required platform, ladders etc. to facilitate approach to various tanks, manholes/hand-holes, sight-glass, operation & maintenance of valves, instruments etc. shall be provided.

z) Interconnecting piping, valves, fittings etc.

4. CHEMICAL STORAGE & DOSING SYSTEM

a) Complete system for coagulant handling, preparation and dosing system comprising the necessary bulk coagulant storage tanks, required structures, operating platforms, ladders etc., Coagulant unloading cum transfer pumps, its drives, required suction & discharge piping, valves, fittings etc., required numbers of Coagulant preparation tanks & its accessories, required numbers of Coagulant dosing pumps, its drives, piping, valves, fittings etc., dosing piping from the pumps up to the clarifiers.

b) Complete system for coagulant aid handling, preparation and dosing system comprising the necessary coagulant aid preparation tanks, required structures, operating platforms, ladders etc., required numbers of Coagulant aid dosing pumps, its drives, piping, valves, fittings etc., dosing piping from the pumps up to the clarifiers as the case may be and as required for the process.

c) Bulk antiscalant storage tank(s), required numbers of Anti-scalant preparation tanks & its accessories, required number of Anti-scalant dosing pumps, its drives, required suction & discharge piping, valves, fittings, etc., dosing piping from the pumps up to the dosing point as required for the process.

d) Bulk antioxidant storage tank(s), required numbers of Anti-oxidant preparation tanks & its accessories, required numbers of Anti-oxidant dosing pumps, its drives, required suction & discharge piping, valves, fittings, etc., dosing piping from the pumps up to the dosing point as required for the process.

e) Required numbers of Hydrochloric Acid unloading cum transfer pumps, its drives, required suction & discharge piping, valves, fittings etc., required numbers of Bulk storage tanks for Hydrochloric acid of 30-33% concentration & its accessories, required numbers of Acid (HCl) measuring tanks & its accessories, required numbers of Acid (HCl) dosing pumps/ejectors for pH control of RO system and for Mixed Bed regeneration, its drives, required piping, valves, controls etc., dosing piping from the pumps up to dosing points and whenever pH control is required as per process requirement.

f) Required numbers of Sodium Hydroxide (Alkali) unloading pumps, its drives, required suction & discharge piping, valves, fittings etc., required numbers of Sodium Hydroxide (Alkali) transfer cum re-circulation pumps, its drives, required suction & discharge piping, valves, fittings etc., required numbers of Bulk storage tanks for Alkali (NaOH in lye form), operating platforms, ladders, etc., required number of Alkali preparation tank & its accessories, required numbers of Alkali measuring tanks for pH control of RO System & its accessories, required numbers of Alkali (NaOH) dosing pumps/ejectors for pH control of RO system and Mixed Bed regeneration, its drives, required

piping, valves, fittings, etc., dosing piping from the pumps up to dosing point wherever pH control is required as per process requirement.

g) Required platform, ladders etc. to facilitate approach to various tanks, manholes/hand-holes, sight-glass, operation & maintenance of valves, instruments etc. shall be provided.

h) Required number emergency safety shower with eye wash units in the Chemical Storage Handling facility at each locations such as Acid/Alkali Storage area, Chemical storage area, Chlorination plant area and Chemical preparation & doing equipment area.

i) All Interconnecting piping, valves, fittings etc.

3.00.00 Mechanical Ventilation system for various buildings like chlorination building, chemical house, pump houses, MCC rooms/Switchgear rooms and toilets etc.

4.00.00 Required number of Drainage pumps of capacity as mentioned in data sheets along with all accessories.

5.00.00 Any other equipment required to meet the System/Technical Specification requirement.

6.00.00 **REVERSE OSMOSIS PLANT FOR WASTE WATER**

A Reverse Osmosis plant for Waste water to treat waste water from CMB shall be provided. The broad scope of RO Plant for waste water shall include but not limited to the following systems and equipment:

a. Pre-treatment system including one (1) number of Clarifier with stilling chamber and inlet chamber, associated channels of RCC construction, two (2) numbers of Gravity sand filters.

b. Ultrafiltration (UF) skid (2x50%), required numbers of self-cleaning strainers, UF permeate storage tank, UF permeate transfer pumps, Cartridge type filters, associated pumps, blowers, interconnecting piping, fittings, valves, chemical storage & dosing system etc. as per system requirement.

c. Required numbers of RO High pressure pumps, RO Streams/trains (2x50%), required numbers of RO permeate water storage tank and automatically operated reject control valves, piping, fittings etc.

d. Complete Chemical handling, storage & dosing system for Pre-treatment plant, UF&RO system.

e. Chemical cleaning and Flushing system for UF & RO system comprising of tanks, pumps etc.

f. Required numbers of RO Permeate-transfer pumps to pump permeate to FGD System Auxiliary Cooling water system & DM/RO system with individual motorised isolation valves in each line.

g. Required numbers of RO reject water pumps (if required) to pump RO Reject water to Coal handling plant for Recycle/reuse of RO reject, all piping, valves, fittings etc. as per system requirement.

h. The Reverse Osmosis plant for Waste water to treat waste water from CMB shall be designed to achieve zero liquid discharge from the plant and the minimum capacity of the same is specified. However, if any additional capacity or additional system is required to achieve complete zero liquid discharge plant, the same shall be provided by the bidder.

.00.00 CONDENSATE POLISHING PLANT

a. Three (3) numbers of identical, separate Condensate Polishing Plants (CPP) for TG (Turbine-Generator) units, along with complete external regeneration systems common for all the Condensate polishing plants shall be provided as detailed out in relevant sub-section of Part-B of Technical Specification. Each Condensate Polishing unit shall consist of four (4) service vessels (4x33.33% capacity) for each TG Unit along with emergency bypass system, resins, blowers, valves, piping etc. Two (2) x 50% cartridge pre-filters for each unit, complete with automatically operated by-pass, associated piping, pneumatically operated valves etc. Two (2) sets of cartridges one each for commissioning & start up shall be provided for each TG Unit.

b. Inclusion of adequate resins for all the condensate polisher service vessels, resin storage vessels (2 nos.) in regeneration area and two (2) additional charge for use during commissioning stage of unit. Therefore, total number of charges supplied by bidder shall be sixteen (16).

c. For regeneration, resin from the exhausted exchanger vessel will be transferred hydraulically/hydro pneumatically through resin transfer pipe line to the regeneration system. The exhausted resin charge will be cleaned, separated, regenerated, mixed and rinsed before being stored for the next use.

d. Regeneration facilities shall consist of but not limited to the following systems and equipment:

Two (2) sets of regeneration facilities consisting of Resin separation vessel, Cation, Anion regeneration vessel(s), Resin make-up hopper, Mixed resin storage vessel, Air blowers & drives, One (1) set of alkali solution preparation & dosing skid, One (1) set of acid solution preparation & dosing skid, Three (3) (3x100%) DM water Pumps for chemical preparation & dilution, Three (3) (3x100%) DM Water Pumps for resin transfer operation, Neutralisation pit, Effluent re-circulation/disposal pumps, Two (2) numbers of DM water Storage tanks, Bulk acid and alkali storage tanks and acid & alkali unloading facilities, Adequate number of safety shower units and Eye-fountains to protect against any chemical hazard, Dosing of acid and lime to neutralize effluents in N.Pit, lime solution preparation facilities for neutralization etc.

e. Waste water generated during resin transfer operation shall be collected in collection pit located in the regeneration area & pumped by Resin transfer waste water disposal pumps (2x100%) to ACW system.

f. Any other equipment required for the completeness of the plant as per system requirement and specification requirements as specified in Part-B.

8.00.00 Air Conditioning for DM Plant Lab Building, Water System Control Building & various RIO rooms shall be in the scope of the bidder.

9.00.00 Ventilation for various Pump Houses, MCC Rooms/ Switchgear rooms etc. shall also be in the bidder's scope.

9. The flow in compressed air piping shall be designed for the design capacity of each compressor and the flow in header and ring mains to be designed for the total capacity of working compressors.
10. The maximum velocity to be considered in compressed air and cooling water piping shall be as mentioned elsewhere in Subsection titled "Low Pressure Piping" in Part-B of this Technical Specification.
11. The lifting capacity of EOT crane of Compressor house shall be 125 percent (%) of the weight of the heaviest part to be lifted during erection or operation or maintenance inside the compressor house. However, the minimum capacity shall be 8 Tones.
12. All hot vessels/pipelines/ valves shall be insulated to restrict the outside temperature within 60 deg.C or less with mineral wool (or equivalent), GI wire netting and aluminum cladding/cover.

3.09.00 **Separation of Plant drain (effluents) from Storm water drain**

Arrangements shall be made that effluents and storm water do not get mixed. In general, the following philosophy shall be adopted for separation of plant drain from the storm water drain.

a. Area wash water, Oil/Coal/Ash/Chemical contaminated water are considered as Plant Water.

b. Plant water has to be completely isolated from the Storm/Rain water and only Plant water needs to be treated & recycled/reused for various plant use. Storm water drains will be separated out for free discharge.

c. Area Pit(s)/Sump(s) shall be created broadly in the TG, Boiler, CHP transfer points, Mill & Bunker areas, ESP, Fuel oil, Chemical storage, Chemical unloading areas, and other cluster areas etc.

d. Submersible Pumps (Capacity-2x100%) interlocked with Level control devices shall be installed in the Area Pit(s)/sump(s) to transfer the Plant Water to Waste Service Water Sump (WSWS) located in main power house area or Water Treatment Plant (WTP) area, Ash handling system, Coal Slurry Settling Pond (CSSP), Central monitoring basin (CMB) depending on the quality of Plant water generated and/or proximity.

e. The rain water down comers shall be led to storm water drains without entry of wash water drains into such down comers.

3.10.00 All liquid effluent shall be collected and treated to meet the latest effluent norms prescribed by SPCB/CPCB. The treated effluents conforming to the prescribed standards only shall be recirculated and reused within the plant and the complete plant shall be designed as a Zero Liquid Discharge (ZLD) Plant.

3.11.00 **A. PRE-TREATMENT SYSTEM**

Design criteria of Pre-treatment Plant for Auxiliary Cooling Water and Potable water System (PT-ACW & Potable), DM system (PT-DM):

1) "PT-ACW & Potable" System with minimum two (2) reactor type clarifiers, one (1) number aerator (1x100%) & one (1) number stilling chamber (1x100%) (Common for all the Clarifiers), two (2) Inlet channels of RCC Construction with flow measuring

element (Parshall flume), outlet Channels, Clarified Water Storage Tank, bypass channel to by-pass the clarifier(s). ACW make-up water shall be led by gravity or pumping. Two (2) numbers of Gravity filters (2x100%), associated filtered water reservoir (twin section), pump house etc. Gravity Filter Blowers (3x50%) shall be provided Potable water System.

2) "PT-DM" System with one (1) number reactor type clarifier (1x100%),one (1) number aerator (1x100%) & one (1) number stilling chamber (1x100%), one (1) number inlet channel of RCC Construction with flow measuring element (Parshall flume) and two (2) numbers of Gravity filters (2x100%), filtered water reservoir (twin section), pump house etc. Gravity Filter blowers (3x50%) shall be provided.

3) Three (3) numbers (3x100%) (2W+1S) Filtered Water Transfer Pumps shall be provided for Ion Exchange based DM plant. In case of RO+MB plant be envisaged for DM water, three (3) numbers (2W+1S) Filtered Water Supply Pumps (UF Feed Pumps) shall be provided. Potable water pumps for colony and plant shall be provided as specified elsewhere.

4) Interconnection provision shall be provided between the clarified water outlet channels of ACW System with the DM System to have flexibility in operation.

5) Filter house shall be RCC building.

6) Chemical House: A common two (2) storey Chemical house of RCC construction shall be provided to install various Chemical dosing equipment, pumps, tanks, piping etc. of PT–ACW & Potable, PT–DM, PT-RO plant (As applicable) :

   a) Lime preparation & dosing system consisting of minimum two (2) nos. of RCC lime slaking tanks, minimum three (3) nos. of lime solution Preparation tanks of RCC construction, agitators, lime slurry transfer pumps (2x100%), lime solution dosing pumps (2x100%) etc.

   b) Alum Solution preparation & dosing system consisting of minimum four (4) nos of Alum solution preparation tanks, agitators, alum solution dosing pumps (4x100%) (3W+1S) for PT-ACW Clarifiers, (2x100%) (1W+1S) for PT-DM Clarifier, (2x100%) (1W+1S) for Lamella clarifier/tube settlers etc.

   c) $FeCl_3$ (35–45 % conc.) (in case of PT-RO) preparation & dosing system consisting of minimum two (2) nos. of dosing tanks, agitators, coagulant unloading and transfer pumps (2x100%) (1W+1S), $FeCl_3$ dosing pumps (2x100%) (1W+1S) etc.

   d) PE dosing system consisting of minimum two (2) nos. of dosing tanks, agitators (SS-316), dosing pumps (2x100%) (1W+1S) (in case of PT-RO) etc.

   e) PAC dosing system shall consist of minimum two (2) numbers of dosing tanks, agitators, dosing pumps (2x100%), unloading pumps (2x100%) etc.

   f) Bulk Coagulant storage tanks (2), Coagulant unloading cum transfer pumps (2x100%) (1W+1S), Coagulant preparation tanks (2), Coagulant dosing pumps (2x100%) (1W+1S).

   g) Coagulant aid preparation tanks (2), Coagulant aid dosing pumps (2x100%) (1W+1S).

   h) Anti-scalant preparation tanks (2), Anti-scalant dosing pumps (2x100%) (1W+1S),

   i) Anti-oxidant preparation tanks (2), Anti-oxidant dosing pumps (2x100%) (1W+1S).

j) Hydrochloric Acid (HCL) unloading cum transfer pumps (2x100%), Bulk storage tanks (3) for HCL of 30-33% concentration, Acid (HCl) measuring tanks (2), Acid (HCl) dosing pumps (2x100%) (1W+1S) for pH control of RO system and for MB regeneration etc.

k) Alkali (NaOH) unloading pumps (2x100%) (1W+1S), Alkali transfer cum re-circulation pumps (2x100%) (1W+1S), Bulk storage tanks (2) for Alkali (NaOH in lye form), Alkali preparation tanks (2), Alkali measuring tanks (2), Alkali (NaOH) dosing pumps (2x100%) (1W+1S) for pH control of RO system, Alkali (NaOH) dosing pumps (2x100%) (1W+1S) for MB regeneration etc.

l) Two (2) numbers of electrically operated mono-rail hoists each of 1 Ton capacity in chemical preparation area to handle chemicals from ground floor to first floor.

m) Two (2) numbers of weighing scales at ground floor for weighing of chemicals being handled during storage and preparation.

n) Emergency safety showers with eye wash units shall be provided in the Chemical Storage Handling facility at strategic locations such as Acid/Alkali Storage area, outdoor Chemical storage area, Chlorination plant area and Chemical preparation & dosing equipment area. Filtered water shall be used for safety showers.

o) One (1) number Overhead (OST) Storage Tank shall be provided on the top of chemical house to provide adequate storage of filtered water to be used for preparation of the chemicals, flushing of equipment, back washing of gravity filters etc.

7) Mechanical Ventilation system shall be provided for complete chemical house building covering chemical storage area, chemical preparation area, toilets etc.

8) Chemical house and Filter house shall be RCC buildings.

B. CHLORINATION SYSTEM

Chlorination plants for Auxiliary cooling water system (ACW & Potable-Chlorination) and Pre-treatment plant (PT-Chlorination) shall preferably be installed at a common location.

a) ACW & Potable-Chlorination systems is envisaged near CT basin and shall consist of two (2) (1W+1S) numbers of Chlorinator-evaporator sets. PT chlorination system shall comprise of two (2) (1W+1S) numbers of Chlorinator sets.

b) Chlorination Plant shall consist of required numbers of Chlorine tonners, Evaporators (as applicable), Chlorinators, ejectors, Chlorine water booster pumps, Safety and supervisory Equipment such as Gas masks, Chlorine leak detectors and emergency kits etc. To take care of chlorine leakage, chlorine leak absorption system shall be provided.

c) Mechanical Ventilation system shall be provided for complete building.

d) One (1) no of electrically operated hoist (Capacity-2 Ton), Two (2) no of Weighing scales (Capacity-2 Ton) shall be provided in each chlorination plant. If the chlorination building is common for PT & ACW system, then two (2) numbers electrically operated hoists (Capacity-2 Ton each) shall be provided.

C. LIQUID EFFLUENT TREATMENT SYSTEM (LET SYSTEM)

1. PT - PLANT CLARIFIER SLUDGE DISPOSAL SYSTEM

a) One (1) number RCC sludge pit (in 2 sections) to collect sludge from all the clarifiers of PT-ACW system, PT-DM system & Lamella clarifiers/tube settlers and any other effluent connected to this sump (in case envisaged).

b) Two (2) numbers air blowers (2x100%) (1W+1S) for the air agitation system of the sludge pit.

c) Three (3) (3x50%) (2W+1S) numbers of sludge disposal pumps.

d) Sludge thickener (1x100%)

e) Centrifuge (2x50%)/Belt filter press (2x50%)

2. FILTER BACK WASH WASTE DISPOSAL SYSTEM

a) One (1) number RCC Filter backwash waste collection pit (in 2 sections) to collect the backwash water from all the filters including Ultra filtration system. The filters backwash water shall be collected and recycled back to the PT-ACW clarifier.

b) Two (2) (2x100%) (1W+1S) numbers of backwash disposal pumps shall be provided.

3. WASTE SERVICE WATER TREATMENT SYSTEM

a) One (1) number RCC waste service water sump (WSWS) in two (2) sections shall be provided for collection of waste service water. Service water effluents and other plant effluents from various areas of the plant shall be routed to this waste service water sump. Facility shall be provided to collect free oil from these sumps to MS Oil drum and oil skimmers (2 nos.) Portable oil Centrifuge (1x100%) of suitable capacity shall be provided for reuse of oil.

b) Three (3) (3x50%) (2W+1S) numbers of Waste Service water pumps.

c) Two (2) (2x100%) numbers of Lamella Clarifier/tube settlers of RCC construction of suitable capacity shall be provided to treat the total service water of the plant for reuse.

d) One (1) number of RCC Treated water tank/Service water tank for collection of treated water from Lamella Clarifier/tube settlers. Service water pumps shall be provided to transfer the treated service water to plant service water system.

4. COAL HANDLING PLANT RUN-OFF WATER TREATMENT SYSTEM.

a) Four (4) numbers of Coal Slurry Settling (CSSP) Ponds (minimum size of 40m x 8m x 3m deep) of RCC Construction shall be provided.

b) Two (2) numbers Coagulant-aid tanks (with SS-316 agitators) of MS rubber lined construction.

c) One (1) number decanted water sump of RCC Construction (2 sections) to receive decanted water from above settling ponds.

d) Two (2) numbers (2x100 %) (1W+1S) Coal Decanted Water Pumps.

e) Four (4) numbers (4x25%) (4W) Clarifier Feed Pump (CSSP area)

f) Two (2) Reactor Clarifiers (2x50%) with stilling chamber (1), inlet chambers (2) and RCC channels, distribution chamber etc. shall be provided to receive excess storm water from settling ponds, along with, piping, valves etc.

g) 2x100% Transfer pumps (if applicable) in distribution chamber in CSSP shall be provided to discharge the treated supernatant water to storm water drain.

h) Lime preparation & dosing system consisting of lime slaking tanks , lime solution preparation tanks, agitators, lime slurry transfer pumps (2x100%), lime solution dosing pumps (2x100%) complete with all necessary piping, fittings, feed piping, water supply piping, overflow and drain piping, sampling connections etc.

i) Alum Solution preparation & dosing system consisting of Alum solution preparation tanks , agitators, alum solution dosing pumps (2x100%) complete with all necessary piping, fittings, feed piping, water supply piping, overflow and drain piping, sampling connections etc.

j) Suitable synthetic flocculent dosing shall also be provided to increase the settling rate suspended solids. Flocculent preparation & dosing system consisting of preparation tanks, agitators, dosing pumps (2x100%) complete with all necessary piping, fittings, feed piping, water supply piping, overflow and drain piping, sampling connections etc. shall be provided.

k) The sludge removed from underflow of the clarifier shall be dewatered using the Filter press (2x50%) of suitable capacity for dried coal particles to be reused. Necessary pumps (2x100%), piping, valves etc. shall be provided.

l) Chemical storage and dosing area shall be provided under shed. Chemical storage shall be designed to meet 15 days requirement.

5. CENTRAL MONITORING BASIN

a) One (1) number (in 2 sections) Central Monitoring (CMB) Basin of RCC Construction.

b) Two (2) (2x100%) (1W+1S) numbers of Waste water RO effluent pumps.

6. All liquid effluent shall be collected and treated (as required) to meet the latest effluent norms prescribed by SPCB/CPCB.

D. DM PLANT (ION EXCHANGE PROCESS OR RO+MB PROCESS)

Design criteria of DM plant (Ion Exchange process or RO+MB process):

1) The capacity of DM plant (either by Ion exchange process or RO process) shall be sized to meet the steam water cycle makeup at the rate of 1.5 % (minimum) of the boiler MCR, makeup water for closed cycle ECW system, regeneration & any other requirement as envisaged by the bidder. Additional DM water requirement for Hybrid System (SCR + SNCR) (if applicable) shall also be considered while sizing of the DM water system. However, the minimum capacity of DM plant shall be as specified.

2) Minimum three (3) numbers of DM water storage tanks, each of minimum capacity 2000 cum shall be provided.

If CPU regeneration facilities are located in DM plant regeneration area, total DM water storage requirements for CPU plant may be clubbed with total DM water storage requirements of DM plant as specified above to decide the effective capacity of the DM tanks. Also, minimum three (3) numbers of DM water storage tanks shall be provided.

3) ION EXCHANGE BASED DM PLANT

a) Ion Exchange Demineralising Plant (2x100%) shall be provided. Weak acid Cation exchanger, Strong acid Cation exchanger, Weak base anion exchangers, Strong base anion exchangers shall be designed for 12 hours of operation cycle followed by 4 hours regeneration period. MB unit shall be regenerated after minimum 108 hours of operation followed by regeneration period not exceeding 6 hours.

b) Two (2) (2x100%) numbers of Activated carbon filters with all accessories.

c) Two (2) (2x100%) numbers of Cation (Weak & strong) exchangers units and Anion exchangers units (Weak & strong) with all accessories.

d) Two (2) (2x100%) numbers of Degasser system comprising of Degasser Towers and storage tanks, Air Blowers (2X100% per Degasser unit), three (3) (3x100%)(2W+1S) numbers Degassed water transfer pumps etc.

e) Two (2) (2x100%) numbers of MB unit along with Two (2) (2x100%) numbers air blowers with its drives and all accessories.

f) Complete Hydrochloric acid handling, Alkali handling, measuring tanks and dosage system etc.

g) Two (2) numbers of safety shower units and adequate number of Eye-fountains to protect against any chemical hazard.

h) Brine Solution Preparation Tank and Brine transfer pumps, piping and valves etc.

i) Provision of hot water supply to the ACF units from the hot water tank shall be made for rejuvenation of activated carbon and the DM regeneration pumps to be sized considering above requirement in addition to required for regeneration.

4) RO BASED DM PLANT

A. ULTRAFILTRATION (UF) SYSTEM

a) UF skids (2x50%) (Pressurized type), Simplex strainers (2x100%) (1W+1S) for each stream, UF backwash pumps (2x100%) (1W+1S) along with flushing tanks and pumps, CEB & CIP systems, UF permeate water storage tanks (2), UF permeate transfer pumps (3x50%) (2W+1S) etc.

b) (3x50%) (2W+1S) Micron Cartridge Filter (MCF).

B. RO SYSTEM

a) High Pressure (HP)-RO feed pumps (3x50%) (2W+1S) with one(1) store standby, RO Streams/trains (3x50%)(2W+1S) with module rack assemblies, RO permeate water storage tanks (2), RO Permeate transfer pumps (3x50%) (2W+1S), sampling facilities, reject control valves, Complete system for Chemical cleaning (CIP) and Flushing system comprising of necessary tanks and pumps for RO trains/streams etc.

b) Complete Degassifier system for removal of CO_2 in permeate water from RO units, consisting of minimum one (1) Degasser tower, Degasser/RO permeate water storage tank (2), Degassed Water Pumps (3x100%), RO Chemical dosing system consisting of Anti-oxidant dosing tank and pumps, Anti-scalant dosing tank and pumps etc., etc.

c) Degasser Blowers for Degasser (2x100%) (1W+1S), RO permeate transfer pumps (3W+1S) etc.

d) Mixed bed (MB) unit (3x50%) (2W+1S) along with air blowers (2x100%) and complete regeneration system etc.

5) OTHER REQUIREMENTS FOR DM PLANT

a) Complete Hydrochloric acid handling, measuring tanks and dosage system etc.

b) Complete Alkali handling, storage and dosage system etc.

c) Three (3) numbers of DM water storage tanks with all accessories.

d) Two (2) numbers (2x100%) (1W+1S) DM water pumps for regeneration system.

e) Neutralizing waste disposal system- DM plant Effluent drains shall be connected to the N-Pit and shall be led suitably to Ash handling system. Additionally, provision for diverting N-pit waste to CMB shall also be provided.

f) Backwash waste disposal system for DM plant - Backwash water from AC filters, rinse waste water and fast/final rinse waste water of DM plant shall be connected to the backwash collection pit (DM), UF back wash shall also be led to this backwash pit. Back wash water shall be pumped to the inlet channel of PT-DM clarifier.

g) Two (2) (2x100%) (1W+1S) numbers of backwash disposal pumps shall be provided. Two (2) numbers air blowers (2x100%) (1W+1S) for the air agitation system of the filter backwash pit shall be provided.

h) First fill of filter media for AC filters and first fill of resins for all Ion Exchange units shall be provided.

i) Provision of hot water supply to the ACF units from the hot water tank shall be made for rejuvenation of activated carbon and the DM regeneration pumps to be sized considering above requirement in addition to required for regeneration.

j) 25 NB SS DM water line from Mixed Bed headers to DM plant lab shall be provided.

k) Suitable MS Epoxy Painted elevated access platform to be provided for internal inspection of all the AC Filters, Ion Exchanger vessels, UF, RO skids, Hot water tank, dosing tanks, degasser tower and tank etc.

l) Supply of Anti-scalant and Anti-oxidant as offered for RO skids for a period of one (1) year from the date of successful commissioning of WTP plant shall be provided by the bidder.

m)RO Reject shall be led to Coal handling plant for reuse in dust suppression system.

n) The effluent of RO chemical cleaning shall be led to the sludge pit.

o) Each set of UF Cartridge filters, HP pump skids and RO membrane units shall be aligned in a row forming a RO train/stream for RO system.

p) Adequate space for access and maintenance shall be provided for HP Pumps (at the end of the pump bay) and RO membrane (at the sides) of assembly.

q) CIP & Flushing System skids shall be provided at suitable location.

r) Sufficient numbers of portable type ladders with platform to be supplied for ease of maintenance.

s) A two (2) storeyed Laboratory RCC building for DM plant shall be provided. The ground floor shall typically have office, store room, resin store room, coal analysis room, coal sampling room, toilet blocks etc. The first floor shall typically have office, record room, Pollution laboratory room, Instrument laboratory room, Water analysis laboratory room, Instrument room, Resin testing laboratory, toilet blocks etc. which shall be air conditioned.

t) Chemical laboratory equipment shall be provided as defined elsewhere.

u) DM Plant shall be kept under shed open from side. DM plant regeneration area shall be kept under steel shed.

6) Any other equipment required to meet the system requirement for complete Water-treatment plant and as envisaged by the contractor shall also be provided.

7) All wetted parts in the plant shall be constructed with suitable corrosion resistant material suiting to the fluid.

8) Facilities for maintenance of the pumps by means of mobile cranes or jib crane or gantry cranes shall be provided based on pumps layout.

5. REVERSE OSMOSIS PLANT FOR WASTE WATER

1) A UF+RO Plant for waste water treatment shall be designed considering an inlet TDS of 5000 ppm minimum.

2) Clarifier (1x100%), Gravity sand filter (2x100%) etc. Ultrafiltration skid (2x50%) with self-cleaning strainers at inlet, One(1) number of UF permeate-cum-back wash water storage tank, UF permeate transfer pumps (3x50%), Cartridge type filters (3x50%),

3) RO skid consisting of High pressure pumps (3x50%), RO Streams/trains (2x50%) module rack assemblies, one (1) number of RO permeate water storage tank sampling facilities and automatically operated reject control valves, piping, fittings etc.

4) Complete chemical storage & dosing system for Pre-treatment, UF&RO system, chemical cleaning and Flushing system for UF & RO system comprising of tanks and pumps (2x100%) etc.

5) RO Permeate-transfer pumps (2x100%) to recycle permeate water to DM plant and CT basin.

6) RO Reject shall be Recycled/reused to Coal handling plant for use in coal dust suppression.

4.00.00 MATERIAL HANDLING

4.01.00 Ash handling System

4.01.01 Brief System Description

Ash handling system consists of the following sub systems:

a) Bottom Ash, Economizer ash and Air preheater ash (if applicable) Handling System ,

i) Completely dry type Bottom Ash and Economiser Ash removal system – A continuous system consisting of dry type bottom ash hoppers, mechanical conveyors, crushers and storage silos etc.

b) Dry Fly Ash Conveying system

Two alternatives for pneumatic conveying system are specified for conveying of fly ash in dry form from ESP hoppers upto buffer hoppers. i.e. vacuum conveying system or pressure conveying system

i) Vacuum Conveying System

It shall consist of liquid ring vacuum pumps, material handling valves, cast iron and MS pipes, instrument air compressor etc.

OR

GENERAL TECHNICAL REQUIREMENT OF WATER TREATMENT SYSTEM/PLANT (CONT.)

A). WATER TREATMENT PLANT

1.00.00 **WATER TREATMENT PLANT**

This Chapter describes the system description, minimum Technical Requirements of the Water Treatment plant and associated equipment. The minimum technical requirements for plant and equipment shall include, but not be limited to the following:

1.01.00 **SYSTEM DESCRIPTION**

1) The **Pre-treatment plant** would be designed to remove suspended/colloidal matter in the raw water. Pre-treatment plant shall be provided for Auxiliary Cooling water system and Potable water system (PT-ACW & Potable system), Demineralised water system (PT-DM system). The plant shall consist of minimum two (2) clarifiers of reactor type for PT-ACW & Portable water system & one (1) clarifier of reactor type for DM system. The clarified water shall be taken as make-up to ACW system (CT basin) either by gravity or by pumping. Clarified water shall be used for various systems like HVAC (Air conditioning & ventilation), FGD system, plant service water system, Ash vacuum pump sealing and any other system as envisaged by the bidder. ACW blow down water shall be used for CHP dust suppression system etc. Provision of service water for CHP dust suppression system shall also be kept. Gravity Filters (2x100%) shall be envisaged separately for DM system and Potable water system. The filtered water shall be led to DM plant for further treatment to produce demineralized water of specified quality. A common chemical house shall be provided to store chemicals, dosing equipment etc. Chemical house and Filter house shall be RCC buildings.

2) **ACW Chlorination Plant** (Chlorinator-evaporator sets) shall be envisaged near ACW pump house. **PT Chlorination Plant** (Chlorinator sets) shall be envisaged near Pre-treatment plant. The chlorination plants for ACW system and PT system can also be installed at a common location if layout permits. The Chlorination system shall be provided with chlorine ton containers, instrumentation, Chlorine leak detectors etc. Complete chlorination plant(s) shall be located indoor. Chlorine leak absorption system as plant emergency measure shall be provided for the Chlorination plant(s) to neutralize chlorine leakage from the plant. Chlorination Building(s) shall be a RCC construction.

3) Sludge from all clarifiers/lamella clarifier etc. in Pre-treatment plant shall be led to common sludge sump and treated in Centrifuge and Belt filter press.

4) The contractor shall provide either Ion exchange based DM plant or RO based DM plant.

5) The capacity of DM plant either by Ion exchange process or RO process shall be sized to meet the makeup water requirement of the steam cycle, make up water to close circuit equipment cooling water (ECW) system,

stator water cooling system etc. and any other requirements as envisaged by the Contractor.

6) In case, Ion exchange based DM Plant is provided, the D.M. plant shall consist of two (02) streams (2x100%) and shall comprise of Activated carbon filter, Weak Acid Cation Exchangers, Strong Acid Cation Exchangers, Degasser towers and Degassed water storage tanks, Degassed water pumps & blowers, Weak Base Anion Exchangers, Strong Base Anion Exchangers, Mixed bed Exchangers. The Cation resins shall be regenerated with hydrochloric acid and the Anion resins with sodium hydroxide. The regeneration facilities shall consist of the bulk acid & alkali storage tanks, alkali solution preparation system, acid & alkali measuring tanks and dosing ejectors etc.

7) In case RO based DM plant is provided, the UF+RO+MB combination Plant shall consist of Ultra filtration skids (2x50%), UF permeate water tanks, Backwashing (CEB) system for UF, Clean-In place(CIP) for UF, RO feed pumps, micron cartridge filters, RO High pressure pumps, complete skid mounted RO block (3x50%), Degasser tower and RO permeate (Degassed) water storage tank, Degassed water pumps, Complete chemical dosing systems for RO system, Chemical cleaning skid for RO system, Complete flushing system for RO system, Mixed bed (MB) exchangers (3x50%) along with regeneration system, acid/alkali dosing system, reject disposal system etc. Reject from RO plant shall be recycled and reused in coal handling plant suitably.

8) The DM water of specified quality after mixed bed units (MB units) shall be taken to DM storage tanks. Three (03) numbers of D.M. water storage tanks shall be provided to store DM water.

9) A two (2) storeyed Laboratory RCC building for DM plant shall be provided.

10) DM Plant (either by Ion exchange process or RO process) shall be kept under steel shed open from side. DM plant regeneration area shall be kept under steel shed. DM Pump house shall be kept in open.

11) Effluent treatment system for PT plant: The filter backwash water of PT Plant shall be collected and recycled back to the PT-ACW &Potable Clarifier. The filter backwash water of DM Plant shall be collected and recycled back to the PT-DM Clarifier. Sludge from clarifiers shall be thickened in a thickener and further solidified by using centrifuge/belt filter press.

12) Neutralizing waste disposal system for DM plant: The effluent waste from DM Plant etc. shall be led to a Neutralizing pit (N-pit) and led to Central monitoring basin (CMB).

13) Power cycle blow down shall be recycled to condenser. Provision for recycling the same to the ACW system shall also be kept with suitable quenching arrangement.

14) Coal handling plant run-off waste water shall be collected in minimum four (4) numbers of Coal slurry settling ponds, treated and decanted water shall be recycled/reused in Coal handling plant suitably by using Coal decanted water pumps. Further, Clarifier feed pumps (4x25%), common stilling chamber (1), inlet chambers (2) and reactor clarifiers (2) of RCC construction, RCC channels, distribution chamber etc. of required capacity shall be provided to receive excess storm water from coal slurry settling ponds and discharge the treated supernatant water to storm water drain. Lime, alum and suitable syn-thetic flocculent dosing shall also be provided to increase the settling rate suspended solids. The pH of treated supernatant water is expected to be acidic in nature (pH-2.8-7.8) and same shall be neutralized prior to discharge in storm water drain. Necessary lime dosing facility for neutralization like preparation tanks, dosing tanks, pumps (2x100%), piping etc. shall be provided. The sludge removed from underflow of the clarifier shall be dewatered using the Filter press (2x50%) for dried coal particles to be reused.

15) Service water effluents etc. from various plant areas shall be separately collected in Area pit(s)/sump(s) and pumped to the Waste service water sump (WSWS). DM plant neutralized effluent, excess storm water from settling ponds after treatment etc. and other plant effluents as required shall also be led to the WSWS. The effluents shall further be pumped up to tube settlers/lamella clarifiers (2x100%) for treatment of suspended solids. Treated service water shall be recycled for use. Provision for diverting the treated service water to CMB shall also be kept. Portable type oil skimmer(s) & a Portable oil centrifuge etc. shall be provided. An effluent management scheme for the plant consisting of collection, treatment, maximum recycle & reuse shall be adopted by the contractor in order to optimize the make-up water requirement and minimizing various plant effluent water. Excess ACW slowdown/Treated plant water/effluents etc., effluent from different areas as envisaged by the contractor shall further be collected in Central Monitoring Basin (CMB) & further treated in Waste water RO plant for meeting and maintaining the zero liquid discharge of the station.

2.00.00 TECHNICAL REQUIREMENTS OF PRE-TREATMENT PLANT

2.01.00 GENERAL

1) The aerator shall be of stepped design and shall allow water to flow downward after spreading over inclined thin sheets and the turbulence is secured by allowing the water to pass through a series of steps and baffles. Cascade aerators designed based on the surface flow rate of not less than 0.03 $m^2/m^3/hr$. Exposure time shall be suitably designed by providing adequate number of steps in the aerator.

2) The volume of stilling chamber shall have a retention time of minimum 1 minute and velocity of water rise through the stilling chamber shall be 0.05 m/sec.

3) The chlorine dosing shall be done in stilling chamber and aerator by using diffusers of proven design. Water from the aerator launder shall be led into the stilling chamber. The stilling chamber shall be provided with a baffle wall so that water shall enter the chamber from the bottom with the velocity specified elsewhere. Draining arrangement with a valve shall be provided for the stilling chamber.

4) The hydraulic circuit of the complete Pre-treatment plant shall be designed in such a way that water from aerator shall flow by gravity up to the clarified water tank under various flow rates up to maximum flow and the top water level in the clarified water storage tank/distribution chamber shall be maintained as +4.5 M (minimum) from the finished ground level.

5) All the clarifiers shall be designed to operate simultaneously.

6) Hydraulics of the Complete Pre-treatment Plant shall be designed to take an occasional over loading of 20% over the design flow.

7) Pre-treatment plant shall be designed such that CW clarifiers can be bypassed. A back-up line shall be provided between ACW Clarifier outlet channel & DM Clarifier.

8) Layout for Pre-treatment plant shall be designed in such a way that various units (e.g. stilling chamber, clarifiers, chemical house, filter house operating platform etc.) shall be interconnected by at least 1 M wide walkways at the appropriate elevations with hand railings.

9) All the chemicals to be used in the Pre-treatment plant shall generally conform to the requirement of technical grade as per relevant IS.

10) Clarified water distribution chamber/tank shall be covered.

11) All the tanks shall be provided with vent, overflow, drain and sample connections. Effective capacity for chemical tanks & water retaining structures/tanks/sumps means the capacity between the bottoms of the overflow nozzle to the top of the outlet nozzle. Outlet nozzle center line shall be kept at least 200 mm from the invert level of the chemical tanks/water retaining structures/tanks/sumps**.** All the covered sumps shall be provided with minimum two (2) numbers of manholes and suitable venting provisions.

12) A minimum free board of 300 mm shall be provided in all the water retaining structures of PT Plant (such as stilling chamber, channels, clarifiers, clarified water storage tank, filtered water reservoir, filtered water sump, overhead filtered water tank, CMB, service water tank etc.) above the maximum water level/overflow level as the case may be excluding the thickness of the slab/beam thickness if any.

13) Any other pumps, blowers required for the completeness of the system shall be designed with a redundancy of N+1 unless stated otherwise (N=No of working pumps, blowers)

2.02.00 **REACTOR CLARIFIER UNITS**

1) The clarifier shall be solid contact reactor type with integral variable speed impeller/ turbine to internally re-circulate water and sludge at adjustable rate to produce consistent water quality at varying hydraulic load and turbidity. The unit shall be designed with a minimum retention time of 90 minutes in the settling zone.

2) The overall area of the unit shall be based on an average flow velocity not more than 3 M^3/M^2/hr. Weir loading shall not exceed 300 M^3/m/day. For uniform overflow over weirs, triangular notches (saw tooth weir) shall be provided as necessary.

3) Design of the sludge removal system should be such as to reduce loss of water during sludge blow off within 3% of rated flow.

4) Clarifiers shall be sized such that in the event, one (1) clarifier is out of service for maintenance, the other clarifiers with 20% overload will be able to meet the total clarified water requirement.

5) The clarifier periphery (all around) shall have a walkway (minimum width 850 mm) with handrail and access ladder (RCC) (at least from two locations) for good approach. All the Reactor clarifiers shall be equipped with full bridge of sufficient width. Permanent ladders shall also be provided (not rungs) for approaching the sludge pipeline valves for maintenance. However, the sludge valves shall be operatable from the top of the sludge chamber through head stock and extended spindle arrangement.

6) Sludge blow off shall be effected by the static head of water in the clarifier unit. Sludge outlet pipes from the concentrated sludge hopper shall be branched into main disposal line and continuous sludge disposal line. Main sludge disposal line, which includes a blow-off valve, shall drain sludge to the sludge disposal sump. Continuous sludge disposal line consists of telescopic stand pipe, the top of which is maintained at a desired elevation to ensure trickle flow of water or sludge water mixture to the sludge sump.

7) Each of the clarifier shall be provided with a gate at the outlet for isolation of any of the clarifier for maintenance.

2.03.0 THICKENER

a) The sludge thickener shall use the technique of liquid solid separation by gravity setting and thickening of the clarifier sludge.

b) These thickener shall reduce the sludge quantity to be handled by downstream equipment viz. solid bowl type centrifuge/belt filter press.

c) The sludge shall be pumped to the sludge thickener and dosed with polyelectrolyte to assist the thickening process. The supernatant from the thickeners shall be gravitated to the head works. Sludge from the thickeners will be pumped to a suitable thickened sludge sump from where it shall lead to the centrifuge system.

d) The thickeners shall have sludge feed piping located below the thickener floor or at the top as per manufacturer's standard. Adequate permanent flushing connections shall be provided for inlet feed pipe as well as the effluent thickened sludge pipe.

e) The thickener shall be steel tank. The floor slope shall be between 10 and 20 degree to the horizontal plant equipped with mechanical scraper.

f) The mechanical scraper drive arrangement shall be electrically operated.

g) The thickener shall be designed for maximum overflow loading rate of 25 $m^3/day/m^2$ and maximum solid loading rate of 100 kg/day/ m^2. Minimum side water depth (SWD) should be 3.5 meter. Hydraulic circuit shall be such that overflow from thickener shall flow by gravity. Hydraulic of the system shall be such that it can take 20% overloading.

h) The thickener shall be capable of thickening the sludge to 7% solid consistency.

i) All parts inside the thickener coming in contact with sludge shall be painted with three (3) coats of bitumastic heavy duty paint. Other metallic components shall be painted with one (1) coat of red lead prime and three (3) coats of suitable rust preventive painting.

j) Suitable sampling connections shall be provided in the thickener of performances monitoring.

k) Polyelectrolyte dosing facility required for thickening shall be provided for which necessary piping, pumps, valves etc. shall be supplied by bidder.

l) Suitable access rungs, ladder, platform, hand railing etc. shall be provided as per manufacturer's standard design.

2.04.00 **CENTRIFUGE /BELT FILTER PRESS**

a) The centrifuges shall operate with the technique of liquid solid separation of differential centrifugal force.

b) The centrifuge/belt filter press shall be used for dewatering the sludge coming out of preceding thickener.

c) The solid bowl centrifuge shall have the system components (indicative) for effective performance like feed tube, bowl, conveyor scroll, gear box, discharge ports for solid and liquids, housing, drive motor etc.

d) The centrifuge/belt filter press shall be designed for continuous operation. The centrifuge shall be either be co-current or counter-current design as per manufacturer's standard. The axis of rotation of the unit shall be horizontal.

e) The feed shall be pumped into the centrifuge/belt filter press by the help of screw pumps. The centrifuge/belt filter press shall be located at an elevated platform. The solids from the centrifuge/belt filter press shall flow by gravity. The elevation of the centrifuge/belt filter press platform shall be at least 3.5 M above ground level so that clearance below the chute shall be suitable for

truck/trolley movement. The centrate shall be sent back to thickener by gravity.

f) For dewatering the fine suspended solids, suitable polyelectrolyte shall be dosed in the centrifuge/belt filter press. The recovery of solids shall be at least ninety (90) per cent with poly electrolyte dosing. The feed to centrifuge/belt filter press will contain about 5 to 7 per cent solids. The solids cake discharge from centrifuge/belt filter press shall have minimum twenty five (25) per cent solids and shall be of tractable consistency.

g) The centrifuge/belt filter press shall be provided with washing lines which shall allow clearing of centrifuge/belt filter press.

h) The centrifuge shall be provided with either an epicyclical gear box or cycle gear box as per manufacturer's standard. The centrifuge/belt filter press shall be provided with anti-vibration arrangement for reducing the vibrations. Overload safety for the gear box shall be provided as per manufacturer's standard.

i) All parts coming in contact with the fluids shall also be made of SS-316 material.

j) Polyelectrolyte dosing facility shall be provided. Necessary piping, pumps, valves, etc. shall be supplied by bidder for this purpose. Common polyelectrolyte dosing facility for centrifuge & thickener is also acceptable.

k) Suitable flushing connection with plug/tanks shall be provided for all pipe lines carrying sludge. Pressurized water supply for flushing shall be provided.

l) Suitable access rungs, ladder, platform, hand railing etc. shall be provided as per manufacturer's standard design.

2.05.00 **FILTERS**

2.05.01 **GRAVITY FILTERS**

1) The inlet channel from clarifiers to gravity filters shall be designed considering operation of all the gravity filters including standby filters under exigency.

2) Filter box of gravity filters shall be of water tight RCC structure covered with RCC roof. Gravity filters shall be twin section type complete with a rate of flow indicator and a loss of head gauge.

3) Gravity filters shall be designed for surface flow rate not more than $5m^3/m^2/hr$.

4) Only one filter shall be backwashed at a time. Backwashing of filters shall be done in not less than 24 hours.

5) The velocity of water during backwashing shall not exceed 35.0 m /hr, when air scouring is employed.

6) Effective Capacity of both sections of the filter water reservoir (excl. common sump) shall be adequate to store filtered water output from one complete filter for one (1) hour.

7) At least 50% free board shall be left over the filtering media to facilitate backwashing.

8) The filtering medium shall be washed, screened and hydraulically graded anthracite coal or sand having an aggregated depth not less than 1200 mm.

9) Details of various layers of Gravity filter medium should be as follows:

150 mm of No.	7 size	60 mm X 50 mm
100 mm of No.	6 size	40 mm X 20 mm
75 mm of No.	4 size	15 mm X 8 mm
75 mm of No.	3 size	8 mm X 4.5 mm
50 mm of No.	2 size	4.5 mm X 2.8 mm
750 mm of No.	1 size	0.45 mm to 0.7 mm effective size

Anthracite shall have the following properties: -

Uniformity coefficient	1.6
Hardness	2.5 to 3.5 (Mho. scale)
Dust content	Less than 1%
Specific gravity	1.75 (Approx.)

Anthracite shall be free from iron sulfide, clay, shale, long, thin or scale pieces.

Sand shall have the following properties: - Sand shall be of hard and resistant quartz or quartzite and free of clay particles, soft grains and dirt of every description.

Effective size shall be 0.45 to 0.70 mm.

Uniformity coefficient shall not be more than 1.7 or less than 1.3

Ignition loss should not exceed 0.7 per cent by weight.

Soluble fraction in hydrochloric acid shall not exceed 5.0% by weight.

Silica content should not be less than 90%.

Wearing loss shall not exceed 3%.

Specific gravity shall be in the range between 2.55 to 2.65.

Sand should be clean and well graded. Sand filter shall have a HCL solubility of less than 5% when tested in accordance with AWWA B 11.53.

10) Each filter bed shall be provided with a rate of flow indicator and a loss of head gauge in a local instrumentation panel which shall be located at suitable location on the operating platform of filters. Each filter bed outlet shall be provided with rate of flow indicator & controller.

11) Each of the gravity filters shall be provided with drain connections with isolating valves for draining complete filter water channel and filter bed. Platform over each of the gravity filters with hand railing shall be provided for the inspection of backwashing operation and filter bed.

12) The manual extension spindles of all the valves of filters shall be operatable from the operating floor of filter bed. Extension spindles and C.I. head stocks for operation of these valves shall be provided. Only valves shall be used for different process of filters. Penstocks/Gates in filter beds will not be accepted.

13) The arrangement of Gravity Filters, filtered water reservoirs, filtered water sump and filtered water pump house for PT-DM and PT-Potable system shall be located together. However, operating floor level of both the filtered water pump houses may be common.

2.05.02 **FILTER BACK WASHING**

1) Filter Back Washing: An overhead storage water tank shall be provided on top of chemical house. The capacity of the overhead filtered water tank shall meet the water requirement for backwashing and backwash flow for simultaneous backwash of one (1) number of gravity filter (both the sections) of Potable System and one (1) number gravity filter (both the sections) of DM and preparation of chemicals etc. and any other requirements envisaged by the contractor.

2) The inlet distribution and under drain collecting system shall be so designed as to give uniform distribution and flow without channeling and obstruction. The under drain system shall either be of header lateral or manufacturer's standard design.

2.05.03 **CARTRIDGE FILTERS**

1) The filter elements shall be cylindrical cartridges constructed from polypropylene fibers, which have a 1 micron nominal 95% efficient rating. Cartridge shall be self-supporting with no reinforcing structures or resins. Polypropylene material shall be 100% polypropylene with no binders, resins lubricants or other residue from the manufacturing process. The filter vessel shall be designed in accordance with ASME boiler and pressure vessel code section VIII, division I. Filter Casing & Internals for Cartridge filters shall be SS-316. Each vessel shall have type bolts and nuts of SS. Each vessel shall have a cover gasket with Buna-N "O" rings. The vessel shall be provided with both clean and dirty water drain nozzles, as well as an air vent at the top. Each vessel shall be provided with a cover-lifting davit arrangement capable of lifting the cover and swinging it to the side. A flanged inspection port shall be installed on the clean side plenum 90 degree from the inlet center line.

2.05.04 **AIR BLOWERS FOR FILTERS**

1) Air blower shall be used for air scouring of filter bed. Blower shall be positive displacement, twin lobed rotary blower. The blower shall be V-belt/directly coupled with electric motor. The blowers shall be oil free type.

2.05.05

ULTRAFILTRATION SYSTEM (UF)

1) Each UF train/stream shall have 15 % spare capacity in order to install additional membranes.

2) UF system shall be pressurized type. The pressure tube shall be side port type and of FRP material. Rated pressure of pressure tubes shall be at least 10% higher than maximum pressure encountered in the system.

3) Membranes shall be of hollow fiber type of PVDF/Polysulphone/ Polyethersulphone material. The pore size of membranes shall not be more than 0.04 microns. Gross flux of membranes shall not exceed 60 LMH.

4) Each stream shall be provided with two (2) (1W+1S) automatic type simplex strainers (100 microns) at inlet to membrane skid.

5) Membrane cleaning system shall be provided as per recommendation membrane designer and membrane manufacturer. The effective capacity of each cleaning tank shall be 120% of chemical required for one (1) cleaning or 0.5 cum. whichever is higher. For each chemical, preparation cum dosing tank shall be provided with agitator, level indicator and pump interlock. The preparation cum dosing tank shall be of MSRL/FRP construction with minimum 6.0 mm thickness.

6) Two (2) numbers of UF permeate storage tanks shall be envisaged to store water to supply feed water to RO system on continuous basis and also to provide water for back washing of UF membranes. Capacity of the tanks shall be calculated based on gross requirement of simultaneous operation of RO & UF backwashing system. A margin of minimum 50% of back wash water requirement shall be considered while calculating capacity of the tanks.

7) Back washing of membranes shall be done automatically and backwash waste shall be pumped to clarification system of Pre-Treatment plant. CEB, CIP shall be provided and the same shall be as per the recommendation of membrane manufacturer.

8) Arrangement/facilities for Direct Integrity Testing, like air pressure system, sonic leak detection etc., to detect any leak from fibers/ membranes/cartridges/modules, gaskets, values, fitting etc. which may contaminate the filtrate shall be provided.

9) Design calculations of Ultra filtration system shall be vetted by membrane manufacturer during detailed engineering.

10) The UF membranes shall be supplied from one of the following membrane manufacturers:

DowChemicals/Toray/Hydranautics/Inge/Hyflux/Koch/Norrit-Pentair/GE.

2.06.00

CHEMICAL HOUSE

A. CHEMICAL HOUSE FOR PT PLANT

1) Chemical dosing equipment, pumps, tanks, piping etc. of PT- ACW & Potable, PT- DM /RO plant (as applicable) shall be located in a common two (2) Storey Chemical House. The Chemical House shall store chemicals in the ground floor whereas equipment such as chemical preparation tanks and dosing equipments shall be installed on the first floor. The chemical house shall be located such a way that chemical dosing pipelines to PT plants, DM plant are minimum.

2) Preparation & dosing equipment of each type of chemical shall be isolated/segregated to avoid mixing of chemicals, facilitate safe operation, easy movement of personnel during plant operation and emergency condition like chemical leakage etc.

3) Suitable platforms, ladders etc. to facilitate approach to various tanks, manholes/hand-holes, sight-glass, operation & maintenance of valves, instruments etc. shall be provided. Chemical house shall have sufficient unloading space, wide corridors for movement of chemicals, office and toilets.

4) Storage area (Alum, Lime, other chemicals etc.), Chemical preparation tanks area, Chemical drain trench & dyke wall shall be provided with corrosion resistant (AR) tiles/lining to protect the surface due to spillage/drains etc.

5) Drains from chemical storage & preparation facility/equipments shall be designed so that the same are not mixed with storm water drainage.

6) Chemical house in the ground floor shall be designed to store the chemicals for one (1) month period considering working of all the clarifiers/tube settlers etc.

   a) Alum as $Al_2(SO_4)_3$: 70 ppm on 100% basis

   b) Lime as $Ca(OH)_2$: 30 ppm on 100% basis

   c) Coagulant aid : 2 ppm

7) Lime slacking tanks: Each tank shall be sized for holding lime slurry (of about 10% W/V concentration from Quick lime of purity of 75% CaO) for 12 hours requirement of all the clarifiers/lamella clarifiers operating at design capacity and a design dosage rate of 30 ppm minimum.

8) Lime solution preparation tanks: Each tank shall be sized for holding lime solution (of about 6% W/V concentration) for 8 hours requirement of all the clarifiers operating at its design capacity and a design dosage rate of 30 ppm minimum.

9) Alum Solution Preparation tank: Each tank shall be sized for holding alum solution (of about 10% W/V concentration) for 8 hours requirement of all the clarifiers operating at its design capacity and a design dosage rate of 70 ppm minimum.

10) Coagulant aid (Poly electrolyte) Preparation tank: Each tank shall be sized for holding coagulant for minimum 12 hours requirement of all the clarifiers operating at design capacity and a design dosage rate of 2 ppm minimum.

11) $FeCl_3$ (35–45 % conc.) Preparation & dosing system consisting of preparation tanks, agitators (SS-316), coagulant unloading and transfer pumps (2x100%) (1W+1S) dosing pumps (2x100%) (1W+1S) in case of PT-RO.

12) PAC unloading, Preparation & dosing system consisting of at least two (2) numbers of tanks, agitators (SS-316), unloading and transfer pumps (2x100%) (1W+1S) dosing pumps (2x100%) (1W+1S) etc.

13) Any other system/equipment required to meet the System requirement shall be provided.

B. CHEMICAL STORAGE & DOSING SYSTEM FOR RO PLANT

1) Bulk chemical storage of RO chemicals i.e. Coagulant aid, Anti-scalant and Anti-oxidant etc. shall be located at ground floor level. Storage area shall have suitable partitions, physical separations/segregations etc. for each chemical.

2) Bulk storage for Coagulant, acid and alkali shall be located outdoor near the chemical house building. Coagulant/Acid/Alkali unloading pumps and alkali transfer pumps shall be located near chemical storage. Spill containment wall (dyke) shall be provided around chemical storage area in such a way that any chemical spill, during unloading, breakage/failure of tanks etc. is isolated from adjoining area by providing dyke wall. The height of dyke wall shall be minimum 500 mm or to contain volume of biggest tank whichever is high.

3) The capacity of the Overhead (OST) Storage Tank shall meet the water requirement for backwashing and backwash flow for simultaneous backwash of one (1) number of gravity filter (both the sections) of Potable System and one (1) number gravity filter (both the sections) of DM/DM-RO and any other system as envisaged by the contractor.

4) Vehicular approach from plant roads shall be provided for easy unloading and handling of chemicals delivered to the plant. This facility shall be located such a way that chemical dosing pipelines to PT plant, DM plant, RO plant for waste water etc. are minimum.

5) Emergency safety showers with eye wash units shall be provided in the Chemical Storage Handling facility at strategic locations such as Acid/Alkali Storage area, outdoor Chemical storage area, Chlorination plant area and Chemical preparation & doing equipments area.

6) Any other system/equipments required to meet the System requirement shall be provided.

7) Layout of Chemical house and Chemical storage area shall be finalized during detailed engineering.

2.07.00 **ACW & PT CHLORINATION**

1) Chlorine dosing shall be provided at aerators, stilling chambers of PT system. In addition, chlorine dosing shall also be provided in filtered water sumps of Potable water system. For controlling organics in Auxiliary circulating water system, Chlorine dosing shall be provided.

2.07.01 **ACW-CHLORINATION SYSTEM**

1) Design capacity of chlorinators shall meet requirement for Chlorine dozing for the total circulating water flow to maintain minimum 0.5 ppm free available residual throughout the treatment.
2) Number of chlorine water booster pumps shall be equal to the number of gas chlorinator and design flow of each pump shall be sized to suit the requirement of one chlorinator so that maximum allowable chlorine concentration is limited to 2500 ppm in chlorinated water.
3) The Chlorine toners shall be located in chlorination building or in a separate chlorine toner store building as the case may be.

2.07.02 **PT-CHLORINATION SYSTEM**

1) Design capacity of chlorinators shall meet requirement for Chlorine doze for the total circulating water flow to maintain minimum 0.5 ppm free available residual throughout the treatment.
2) Number of chlorine water booster pumps shall be equal to the number of gas chlorinator and design flow of each pump shall be sized to suit the requirement of one chlorinator so that maximum allowable chlorine concentration is limited to 2500 ppm in chlorinated water.
3) The Chlorine toners shall be located in chlorination building or in a separate chlorine toner store building as the case may be.

2.07.**03** **PT & ACW CHLORINATION**

1) To handle the ton-container, two (2) number electrically operated monorail hoist of 2 tonne capacity along with load indicator of 2000 Kg shall be provided.
2) Safety equipments as recommended by Chlorine Institute-USA shall be provided.
3) All the equipment in the system shall be sized for absorption of one (1) tonner of chlorine liquid leaking out from a tonner within one (1) hour for common building. All the tonners shall have one (1) hood of FRP in two (2) halves as required for the system.
4) Chlorine leak sensors shall be provided for all the connected chlorine ton containers and in other leak prone areas as per system requirement.

2.08.00 **OTHER DESIGN & CONSTRUCTION FEATURES**

1) All the metallic parts of equipments of Complete Pre-treatment and LET system, which are embedded in concrete or in contact with water, shall be painted with bitumastic heavy duty paint over a coat of primer with total thickness of 400 microns. All the other parts of the PT plant shall be painted with one coat of primer and three coats of chlorinated rubber paint and total thickness shall be 200 microns.

2) All the tanks shall be provided with vent, overflow, drain and sample connections. Outlet nozzle center line shall be kept at least 100 mm from the invert level of the chemical tanks/water retaining structures/tanks/sumps. A minimum free board of 300 mm shall be provided in all the water retaining structures above the max. water level /overflow level as the case may be excluding the thickness of the slab/beam thickness if any.

2.08.01 The maximum support length in meters for MS pipe as follows

a)	PIPE DIA (MM)	1200	1000	800
b)	SPAN (METERS)	12	10	10

For pipe sizes less than 800 NB, span shall be provided as per ANSI B31.1

2.08.02 The overflow & drains from the various chemical tanks and floor wash drains of chemical house building shall be led to sludge sump.

3.00.00 **CONTROL PHILOSOPHY OF WATER TREATMENT PLANT**

3.01.00 The control & operation of various systems described below is indicative only and the actual control & operation philosophy shall be finalized with during detailed engineering. However for all the systems, following basic process related interlocks, alarms /pre-warning signals shall be implemented in the control system as per system requirement.

a) Among the equipment, it shall be possible to select a specific pump or tank or sump for working/standby/ maintenance etc. through control system.

b) Permissive & Interlocks:

1) Starting & tripping of pumps with respect to liquid level in the respective sump/tanks or liquid pressure in the suction lines.

2) Starting & tripping of agitators with respect to liquid level in the respective sump/tanks.

3) Starting & tripping of pumps (which are provided with forced water lubrication) with respect to lubricating water flow (through low pressure/ low flow signal as the case may be).

4) Tripping of pumps when the discharge pressure is very high to avoid operation of the pump under shutoff head.

5) Stopping/ tripping of equipment due to abnormal parameters related to safety of equipment like high vibration, very high bearing lubrication water (and /or oil) temperature to the drive/pumps, very high bearing temperature of the of pump/drive etc as applicable based on the recommendations of Equipment Supplier.

6) Automatic opening of the re-circulation valve to pre-set percentage, in case of failure of opening of pump(s) discharge valve to ensure minimum flow through the pump, as per the recommendation of manufacturer.

7) Automatic starting of standby pumps upon failure of starting of selected pump or tripping of running pump as the case may be.

c) Alarms /Signals

1) Abnormal parameters such as low & high level in tanks/sumps, high pressure at pump discharge, low header pressure, low lubrication water flow to pumps (provided with forced water lubrication system) etc.

2) Failure of starting of equipment such as pumps, blowers etc. upon start command.

3) Tripping of equipment due to protection logic.

In addition, the control system shall facilitate the operator to know the status of various equipment (Whether equipment is running or stopped or tripped etc, whether the equipment is selected for operation/ standby duty /maintenance mode etc as the case may be).

3.02.00 **SYSTEM OPERATION AND CONTROL PHILOSOPHY (PT PLANT)**

1) **CLARIFICATION PLANT**

The motor operated inlet control valve to clarifiers shall be regulated with respect to the water level in the clarified water storage tank. A variable frequency drive (VFD) shall be provided for turbine/impeller drive of all the clarifiers to control the speed for varying the recirculation rate. The scrapper drives of clarifiers shall be interlocked with torque limit switches on the motors.

2) **CHEMICAL HOUSE**

1) All the pumps shall be interlocked with the level at sump/reservoir/tank for pumps start permissive as well as pump protection. Annunciation prior to trip shall also be provided.

2) Agitator can be started only when the level in the corresponding dosing tank is adequate. The agitator shall trip when the level in the dosing tank comes below a pre-defined set point.

3) Capacity of the metering pump shall be controllable from 10-100% continuously by adjusting the stroke length manually by a micro meter dial calibrated for 0–100% of pump capacity integral with the pump.

4) Various annunciations related to low level of the chemical tanks shall be provided.

3.03.00 **SYSTEM OPERATION AND CONTROL PHILOSOPHY (FOR PT & CW CHLORINATION SYSTEM)**

1) In the event of leakage in chlorine tonner, the chlorine leak sensor shall sense the leakage and start the absorbent recirculation pump, blower and open the motorized/pneumatic damper at blower inlet along with audiovisual alarms.

2) In case of chlorine leakage in adjoining areas, such as chlorinator/evaporator rooms etc, the detectors provided in these areas shall sense the leak and give audio-visual alarms. The blower and pump shall then be started and the damper at blower shall be opened automatically. Essentially, the whole absorption unit shall be under vacuum as soon as the blowers are under operation. The absorbent recirculation pumps, however, are interlocked with a level transmitter in the caustic solution tank and will not start if the level of absorbent is low. In that case, the level transmitter will give an alarm. The leaked chlorine gas is brought to the absorption tower. In the absorption tower, leaked chlorine shall meet counter currently the caustic soda solution. The chlorine gas shall be neutralized in the tower and chlorine free air shall be released to the atmosphere.

4.00.00 **LIQUID EFFLUENT TREATMENT SYSTEM**

4.01.00 All liquid effluent emerging out of the power plant shall be collected and treated (as required) to meet the latest effluent norms of statutory authority.

A. PT PLANT CLARIFIER SLUDGE DISPOSAL SYSTEM

1) One (1) number RCC sludge pit in two (2) sections to collect sludge from all the clarifiers of PT-ACW & Potable system, PT-DM system & Lamella clarifiers/tube settlers etc. shall be provided. Sludge pit shall be able to store the sludge generated in water treatment plant clarifiers and any other drain/effluent connected to this sump (in case envisaged). Sludge pit shall be provided with agitation by recirculation (jetting nozzles) system and air agitation system.

2) Air blowers (2x100%) shall be used for the air agitation system of the sludge pit to avoid settlement of solids. Sludge pumps (3x50%) (Vertical sump pumps) shall be provided to pump sludge to sludge thickener.

3) The thickener (1x100%) shall be provided for thickening of the sludge. The centrifuge/belt filter press (2x50%) shall be provided for dewatering the sludge coming out of preceding thickener.

B. FILTER BACK WASH WASTE DISPOSAL SYSTEM

1) One (1) number RCC Filter backwash waste collection pit in two (2) sections of shall be provided to collect the backwash water from all the filters. The filters backwash water of shall be collected and recycled back to the clarifiers.

2) Backwash disposal pumps (2x100%) shall be provided. Each pump shall be capable of evacuating the capacity of complete pit within 1 hours.

C. WASTE SERVICE WATER TREATMENT SYSTEM

1) Service water effluents (after floor washing etc.), other plant effluents etc. having high-suspended solids require treatment for removal of total suspended solids (TSS). It is proposed to reuse/recycle waste service water after treatment by means of Waste Service Water Treatment System. The system broadly consists of Collection sumps, Tube settlers/Lamella clarifiers, oil skimmers, oil centrifuge, pumps, chemical storage, handling and dosing equipment etc.

2) One (1) number RCC waste service water sump (WSWS) in two (2) sections (each of 250 cum capacity minimum) shall be provided for collection of waste service water. Service water effluents from various areas shall be routed to this waste service water sump. Waste service water from the main plant area shall be terminated at a point as specified elsewhere. Further, from this terminal point, waste service water shall be led to the above waste service water sump (WSWS) with all the associated piping, valves etc. which shall be in contractor's scope.

3) Waste service water transfer pumps (3x50%) shall be installed in WSWS to pump waste service water to a set of Tube settlers/Lamella clarifiers.

4) Chemical dosing (Alum & lime) shall be provided for these Tube settlers/Lamella clarifiers in the chemical house. The treated water form Tube settlers/Lamella clarifiers shall be led to Treated/Service water tank & also to Central monitoring basin (CMB) either by gravity or pumping. Provision for clarified water shall also be kept in service water tank. Sludge from the tube settlers/lamella clarifiers shall also be led to the common sludge pit provided.

5) One (1) number of RCC Treated/Service water tank for collection of treated water shall be provided. Capacity of the tank shall be suitable for storing minimum 30 minutes of discharge from one tube settlers/lamella clarifiers. Service water transfer pumps shall be provided as specified elsewhere for plant service water network etc.

6) Suitable oil skimmers shall be provided in the waste service water sump so that oil impurities floating on the sump is skimmed and collected in a tank located over ground. Facility shall be provided to collect free oil from this sump to a MS oil drum of 200 litre capacity.

7) A Portable oil centrifuge (Trolley mounted) of suitable capacity shall be provided to collect and purify the oil of the Waste Service Water System for use in non-critical units for lubrication purpose or the same shall be disposed of.

D. TUBE SETTLER/ LAMELLA CLARIFIERS

1) Two (2) (2x100%) numbers of Lamella Clarifier/tube settlers of capacity to match with discharge capacity of working waste service water pumps shall be

provided to treat the service water, plant water collected from different areas in the plant. Lamella Clarifier/tube settlers shall be provided with one (1) flash mixer and Flocculation Chamber (RCC construction) at its upstream. Flash mixer shall provide minimum one (1) minute storage at the design flow rate. The water from flash mixer shall flow to a flocculation chamber and from the bottom of flocculation chamber water shall flow to the Lamella Clarifier/tube settler by gravity. The flocculation chamber shall provide 10 minute (min.) storage at the design flow rate. Suitable mechanical stirrer driven by electric motor through speed reducing gearbox shall be provided in each flash mixer and flocculation chamber.

2) The Lamella Clarifiers/tube settlers units shall be designed with side water depth of 4 M minimum. The overall area of unit shall be based on an average flow velocity not more than 5 $m^3/hr/m^2$. The length of the plates through which the water flow shall not be less than 1.5 M. The plates shall be inclined by 50-80 deg. angle to the horizontal. The material of plates shall be UV inhibited virgin PVC. Design of the sludge removal system should be such as to reduce loss of water during sludge blow off within 5% of rated flow.

3) The tube settlers/Lamella Clarifiers shall be of RCC and of proven design. The tube settlers/ Lamella Clarifiers shall be circular/rectangular with distinct tube/plate separation zones, sludge thickener zone, clear water zone and oil skimming zone. The tube settler/Lamella Clarifiers shall be counter flow or cross flow type. Co-flow type units are not acceptable.

4) The tube settlers/Lamella Clarifiers shall employ positive removal system of consistent density, central sludge concentrating sump, water flushing nozzles etc. as per the standard design of manufacturer. Sludge removal system shall be designed to thicken the sludge to minimum 2% consistency before disposing from separator bottom. All the pipelines carrying the sludge shall be provided with suitable flushing connection. Angle of inclination of sludge hopper shall be minimum 55 deg. to horizontal plane for effective collection of sludge.

5) The tube settlers Lamella Clarifiers periphery shall have a walkway of sufficient width along-with hand-railing and access ladders for general inspection. However, the manual sludge valves shall be operatable from the top of the sludge chamber through head stock and extended spindle arrangement.

6) Suitable sampling connections shall be provided for performance monitoring.

7) To remove settled particles from the plates/tubes suitable water jet arrangement shall be provided. Pumping and piping arrangement shall be separately provided for this purpose. The tube/ plates shall be easily accessible for the cleaning purpose. The tube pack/ plates shall be placed inside the separator such that these may be individually removed for maintenance even when separator is operating.

8) Design Conditions for Lamella clarifiers/tube settlers:

	Inlet quality	Outlet quality
TSS	500 ppm (max)	10 ppm (max)
Oil content	50 ppm (max)	5 ppm (max)

E. COAL HANDLING PLANT RUN-OFF WATER TREATMENT SYSTEM

1) The drains from coal handling plant and coal stock pile area where coal is stored contain coal particles. Apart from this, the coal pile-runoff water during the rainstorm will also contain large quantity of coal particles. The drains emanating from Coal Handling Plant shall be routed to coal slurry settling (CSSP) ponds where coal particles shall be settled. After settling decanted water shall flow to the drain by gravity and also to the sump for transferring the same to coal handling plant for reuse. Dosing of Coagulant aid (Polyelectrolyte) solution from a set of coagulant aid storage tanks in the inlet channel of CSSP drain through gravity/pumping shall be provided. Suitable baffles shall be provided in the inlet channel to facilitate mixing of coagulant aid with the waste water before entry to CSSP. Provision shall be made to lead 100% of waste water flow (considering rain flow) to the settling ponds for settling. The decanted water shall be further pumped back to the to the CHP dust suppression in Coal Handling Plant for re-use.

2) Coal handling plant run-off waste water shall be collected in minimum four (4) numbers of Coal slurry settling ponds, treated and decanted water shall be recycled/reused in Coal handling plant suitably by using Coal decanted water pumps (2x100%). Further, Clarifier feed pumps (4x25%), stilling chambers (2), inlet chambers (2) and reactor clarifiers (2) of RCC construction, RCC channels, distribution chamber etc. of required capacity shall be provided to receive excess storm water from coal slurry settling ponds and discharge the treated supernatant water to storm water drain. Lime, alum and suitable synthetic flo-culent dosing shall also be provided to increase the settling rate suspended solids. The pH of treated supernatant water is expected to be acidic in nature (pH-2.8-7.8) and same shall be neutralized prior to discharge in storm water drain. Necessary lime dosing facility for neutralization like preparation tanks, dosing tanks, pumps (2x100%), piping etc. shall be provided. The sludge removed from underflow of the clarifier shall be dewatered using the Filter press (2x50%) for dried coal particles to be reused. Suitable storage facilities under shed shall be provided for the various chemicals.

3) Design settling velocity of the coal particles shall be maximum 5 m/hr.

4) The settling ponds shall be designed to take care of coal stack yard runoff water in storm water conditions. Interconnection shall be provided between the ponds such that flexibility of selecting any pond remains.

5) CSSP shall be designed considering rainstorm condition. However, the capacity of each pond of CSSP shall be not be less than 1000 cum/hr.

6) The exit for run-off water from the settling pond shall be such that the short-circuiting of water is avoided. For this purpose, water shall be allowed to traverse under a breast wall located about 5 mtr. ahead of outlet side of the pond.

7) Overflow water from coal slurry settling pond would be led to a sump. The decanted waste water collected in secondary pond shall be pumped for re-use/recycling.

8) From local grade level, adequate steps/stairs to be provided in coal settling pond for taking out settled coal slurry manually from the pond.

9) Suitable Coagulant-aid (Polyelectrolyte) may be used as an aid to coagulation in coal settling ponds. Bypass arrangement before settling pond & after overflow collection sump during rainfall shall also be provided.

10) An inlet distribution chamber of width 1.2 M (min.) and length equal to width of each pond for each CSSP pond shall be provided for proper mixing of effluents before waste water entry to all the ponds. Over flow level of CSSP shall be less than or equal to invert level of inlet channel of CSSP.

F. CENTRAL EFFLUENT MONITORING BASIN (CMB)

1) One (1) number (in 2 sections) CMB of RCC construction shall be provided to receive treated water of Lamella Clarifiers/tube settlers, excess CW system blow down water, Regeneration waste water from the N-pits of DM Plant and any other effluents as envisaged by the bidder. Sizing of each compartment of the basin will be such that enough dilution water is stored to keep the TDS and other parameters of the mixed effluent below the permissible limit. However, the capacity of each compartment shall be equivalent to minimum 30 minutes flow to the CMB. CMB operation shall be designed in such a way that one section of the pit receive the plant effluent etc. and other section discharge/recirculate the effluent after proper mixing. Combined effluent from CMB shall be led to waste water RO plant by (2x100%) Waste water RO effluent pumps (1W+1S).

2) Final effluent quality monitoring station with instruments such as pH meter, turbidity meter, flow meter, instrument for TDS measurement (conductivity meter) etc. as shown in the tender drawing shall be provided. Any other instruments as prescribed by SPCB/CPCB to meet statutory norms shall also be provided by the bidder. Suitable sampling connections shall be located near Central effluent monitoring basin.

G. REVERSE OSMOSIS PLANT FOR WASTE WATER

A UF+RO Plant for waste water treatment (Design net capacity of RO permeate (minimum) -50 Cum/h) shall be envisaged to teat waste water like excess CW blowdown, treated service water from Lamella Clarifiers/tube settlers, DM plant effluents etc. from CMB. The plant shall be complete with Pre-treatment system like Clarifier, Gravity sand filter etc. Ultrafiltration skid with self-cleaning strainers at inlet, One(1) number of UF permeate-cum-back

wash water storage tank, UF permeate transfer pumps, Cartridge type filters, associated pumps, blowers, chemical storage & dosing system etc., RO skid consisting of High pressure pumps, RO Streams/trains module rack assemblies, one (1) number of RO permeate water storage tank, sampling facilities and automatically operated reject control valves, piping, fittings etc.

1) Complete chemical storage & dosing system for Pre-treatment, UF&RO system, chemical cleaning and Flushing system for UF & RO system comprising of tanks and pumps etc. shall be envisaged.

2) The sludge sump/pit, N-pit, Backwashing sump/pit, chemical storage and dosing system for Waste water RO plant shall be separately designed and envisaged as per the system requirement. If Waste water RO facilities are located in WTP area, common facilities for Waste water RO plant & WTP may be provided. However, in such case the capacity of the various facilities of Waste water RO plant so designed shall be added to the capacities of sludge sump/pit, N-pit, Backwashing sump/pit, chemical storage and dosing system of WTP area described above in order to arrive at the final capacities of the common systems.

3) RO Permeate-transfer pumps (2x100%) shall be provided to recycle RO permeate to CT basin, DM/RO plant. RO Reject water shall be Recycled/reused to Coal handling plant and any other system suitably etc.

5.00.00 ~~**TECHNICAL REQUIREMENTS OF DEMINERALISATION PLANT**~~

5.01.00 **DM PLANT (ION EXCHANGE DEMINERALISATION PLANT)**

1) Each stream of DM plant (Ion Exchange process) shall comprise of Activated carbon filter, Weak acid Cation exchanger unit, Strong acid Cation exchanger unit, Degasser system comprising of Degasser Tower, Degasser storage tank, Air Blowers (2x100%) per degasser tower, Weak base Anion exchanger unit, Strong base Anion exchanger unit, Mixed bed unit along with air blowers (2x100%) with drives, required accessories etc. Degassed water transfer pumps (3x100%) shall be provided.

2) Regeneration facility shall comprise of Acid and Alkali bulk Storage facility, Chemical unloading pumps, Alkali & Acid preparation/measuring tanks, Chemical Dosing system Regeneration pumps etc. shall be provided as per follows:

   a) Bulk acid storage tank (HCl-30-33% Conc.): Minimum three (3) numbers to hold one (1) month requirement of acid for regeneration of all operating DM streams operated at its rated capacity, with specified service cycle, regeneration period and using guaranteed chemical consumption plus any other requirements as envisaged by the contractor to be met through these tanks.

   b) Bulk Alkali storage tank (NaOH 48% Conc.): Minimum two (2) numbers to hold one (1) month requirement of alkali required for regeneration of all operating DM streams operated at its rated capacity, with specified

service cycle, regeneration period and using guaranteed chemical consumption plus any other requirements as envisaged by the contractor to be met through these tanks.

c) Acid unloading pumps, Alkali unloading pumps, Alkali transfer cum recirculation Pumps shall be provided.

d) Two (2) Acid Measuring Tanks shall be provided with effective capacity to hold adequate chemical for 125% of one (1) regeneration of one (1) DM Stream (both Cation & Mixed bed).

e) Two (2) Alkali Day Tanks shall be provided with effective capacity to hold adequate chemical for 125% of one (1) regeneration of one (1) DM Stream (both Cation & Mixed bed).

f) Two (2) Alkali Preparation tanks each of effective capacity of 5 Cu.m and One (1) number Alkali Diluent Water Heating Tank of effective Capacity of 10 Cu.m shall be provided.

g) Three (3) numbers of Degassed Water Pumps (3x100%) with gross capacity of each DM stream (minimum) and Two (2) numbers of DM Regeneration pumps (2x100%) (1W+1S) shall be provided.

h) In addition to regeneration system, a set of Brine preparation tank (1) and brine transfer pumps (2x100%) for pumping brine solution to Anion exchanger vessels to facilitate removal of organics as and when required shall be provided.

i) Neutralizing waste disposal system (DM plant)- All DM plant (Ion Exchange/RO) effluent drains shall be connected to one (1) number of RCC Neutralization pit (in two (2) sections) with acid/alkali resistant lining. Each section of the pit shall hold 150% of waste water generated during regeneration of UF, RO & MB exchanger/one (1) stream of DM Plant or 150 Cu.M whichever is higher. Recycling/disposal pumps (3x100%) shall be provided, each pump capable of evacuating the capacity of each section of the pit within 3 hours.

j) Backwash water from AC filters, rinse waste water and fast/final rinse waste water of Ion-Exchangers units shall be connected to the backwash sump and same shall be led to DM clarifier.

k) First fill of filter media for AC filters, First fill of resins for all Ion Exchange units to be provided.

OTHER DESIGN & CONSTRUCTION FEATURES

1) All the vessel internals of activated carbon filters, Ion Exchange units and Degasser units such as inlet distributor, regenerant distributor, under drain system etc. shall be of proven design.

2) The valves under automatic operation of DM Plant shall be operated pneumatically by diaphragm actuator. Valves shall be spring to close or spring to open or double acting type as may be required by process

consideration. The valves on effluent outlet as well as regenerant inlet of filters and ion-exchangers shall be of spring to close (Air to open) type only. Limit switches shall be provided for all the valves under automatic operation.

3) In case strainer-on-plate design is used for under drain system, additional manhole shall be provided to give access below the bed plate for all units of filters, Ion Exchange Units etc.

4) All valves used with vessels shall be suitably arranged in the front in accessible position, for manual operation in case of emergency.

5) All demineralising streams shall be designed to run continuously at its rated capacity and simultaneously under parallel operation.

6) Activated Carbon Filters (ACF)

a) Design and Fabrication of the vessel should be according to IS: 2825 or equivalent.

b) Maximum velocity of filtration shall be 15 m/hr at design capacity.

c) The activated carbon shall meet the following requirements:

(i) Total surface area (m^2/g) : Not less than 850.

(ii) Particle density (wetted in water) g/cc : 1.3-1.4

d) The selected Activated Carbon Filter (ACF) shall be able to operate continuously for a period not less than three years without any regeneration / activation.

e) Suitable (at least 75%) free board shall be provided over the filtering medium below the backwash outlet nozzle and in straight portion of vessel to facilitate backwashing.

f) Each filter shall be provided with AC filter media trap in effluent line. Media trap shall be provided on backwash outlet line also.

5.02.00 **ION EXCHANGE UNITS**

1) Design and Fabrication of the vessels should be according to IS : 2825 or equivalent.

2) Material of construction shall be mild steel with rubber lining (MSRL) and rubber covered (RC).

3) Under drainage system shall be header lateral or strainer-on-plate type. In case of header lateral system, header shall be mild steel "rubber lined inside and rubber covered outside" (MSRL & RC) and lateral of polypropylene.

4) For Mixed-Bed Exchanger, separate distributor shall be provided for influent and regenerant entry. The influent and alkali regenerant distributor and acid regenerant distributor shall be MSRL & RC. The interface collector & distributor shall be of suitable acid/alkali resistant material. The under

drain collector system shall be header lateral or strainer-on-plate type and shall be adequately designed to ensure uniform distribution of flow.

5) The regenerant distributor and middle collector shall be mild steel rubber lined inside and rubber covered outside. All internal studs /nuts/washers shall be of AISI 304 L for alkali service and Hastelloy-B for acid service.

6) At least 100% free board shall be provided over resin bed below the backwash outlet nozzle and in straight portion of vessel to allow for expansion during backwashing and for addition of extra resin, if required.

7) Each exchanger unit shall be provided with resin traps on treated water outlet line. Resin traps shall also be provided both on the backwash and regenerant outlet lines.

5.03.00 **SURFACE FLOW RATE FOR ION–EXCHANGERS**

The following shall be maximum surface flow rates for the various Ion-Exchangers at the design capacity.

i) Cation unit – 35 $m^3/hr/m^2$ (for both weak and strong Cation)

ii) Anion unit – 35 $m^3/hr/m^2$ (for both weak and strong Anion)

iii) Mixed bed unit – 40 $m^3/hr/m^2$.

1) In case the contractor offers both weak and strong Ion-exchange units (for Cation and/or Anion unit), the surface flow rate for the strong ion exchange unit(s) only may be increased as indicated below, if contractor has adequate experience of designing Demineralisation plants of such higher surface flow rate .

Maximum surface flow rate:-

i) Strong Cation unit – 40 $m^3/hr/m^2$.

ii) Strong Anion unit – 40 $m^3/hr/m^2$.

5.04.00 **REGENERATION SYSTEM**

1) The ion exchange resin shall be regenerated by employing optimum regeneration level to prevent leakage of ions. Cation resins shall be regenerated by hydrochloric acid (30-33% w/v technical grade IS: 265) and anion resins by sodium hydroxide (48% w/v rayon grade in flakes or lye form as per IS: 252).

2) Regeneration system should be designed such that AC filter, cation, anion and mixed bed units of a particular stream can be regenerated simultaneously/ separately at a time.

3) For calculation of anion capacity and silica leakage the temperature of alkali regenerant shall be taken as 25 deg.C. Co-current or counter-current regeneration technique shall be adopted provided the same technique of regeneration was adopted in other plants executed by the contractor. The chemical consumption figures must be supported by relevant published

data such as performance of the resin system and /or actual field performances of plants using a similar technique, indicating the quantity of chemicals required for regeneration, in particular, besides other parameters.

4) The process calculation shall be furnished indicating the various steps of regeneration, regeneration level employed, total and used exchange capacity of resins in various exchangers, resin quantity provided in ion exchange vessel etc. The relevant resin literature & curves indicating various parameters and exchange capacity and regeneration levels selected shall also be furnished during detailed engineering.

5) Regeneration facilities offered shall be complete with acid/alkali measuring tanks, ejectors for dosing of chemicals.

6) For heating of alkali diluent water, 2x50% electrical heating coil in a tank of mild steel rubber lined construction shall be provided. Design and fabrication of the tank should be according to technical specification for Pressure and Storage vessel. The tank shall be sized based on 125% of the regeneration water requirement of one anion and one mixed bed unit

7) The heaters shall be sized for heating the water from a minimum temperature of 15 deg. C to such a temperature that a maximum temperature 50°C can be achieved at the outlet of Alkali ejector. The duration of filling and heating the tank shall not be more than four hours.

5.05.00 **EXCHANGE RESIN**

1) Cation and anion resin shall be of reputed make and must have been in use in demineralising plants capable of producing water of quality as specified or better, for a period of not less than three (3) years.

2) The cation exchanger resin used in the strong cation unit and mixed bed exchanger shall be strongly acidic, high capacity polystyrene resin in the bead form.

3) The anion exchanger resin used in strong anion unit & mixed bed shall be strongly basic, high capacity resin (Type-I) in bead form. The anion resin shall be able to withstand a temperature of 60 deg. C (minimum) continuously. Type-II anion resin shall not be accepted. Strong Base Anion resin (or weak base Anion in case of hookup) shall be MACROPOROUS type only.

4) Weak & strong resins may be regenerated in thoroughfare. Weak and strong resins contained in same vessel will not be accepted.

5) DM water chains shall be designed in such a way that any chain can be regenerated without the necessity of other chain being put into operation.

5.06.00 **WASTE WATER NEUTRALIZING ARRANGEMENT (DM plant)**

1) The demineralising plant shall be designed in such a way that the regenerant effluent is self neutralising. Provision shall however be made to

dose acid, alkali and lime to neutralise the effluent, whenever required. One (1) no. of twin compartment RCC pit for waste neutralization (N-pit) shall be provided. Effluent disposal pumps shall be provided for recirculation as well as disposal of waste.

2) Suitable proven agitation system (e.g. air agitation/venturi mixing etc.) shall be provided for proper mixing and maintaining uniform pH value of the waste water in addition to recirculation system.

5.07.00 **CONTROL & OPERATION OF THE DM PLANT**

1) The control & operation of various systems described below is indicative only and the actual control & operation philosophy shall be finalized with during detailed engineering.

2) Actual logic shall be built in the control system during detailed engineering. Operation of the complete DM Plant (both Service cycle & regeneration cycle) for all streams shall be through the control system.

3) Only basic type of control required is specified. The Contractor has to submit the complete details of the system offered by him like the extent of automation offered, operation of the complete system, logic/flow diagrams, drives/instrument list etc.

4)The sequence startup mode shall be of the following types

i) Automatic Mode:-In this mode of operation, the sequence shall progress without involving any action from the operator. The sequence start/stop command shall be issued from the LVS/OWS.

ii) Semi-Automatic Mode:-In this mode of operation, once the sequence is initialized, the step progressing shall be displayed on the LVS/OWS. But the step execution command shall be prevented and shall be sent by the operator via the mouse. It shall be possible to bypass and/ or simulate one or more criteria to enable the program to proceed. This facility shall allow the program to be executed even if some criteria are not fulfilled because of defective switching device, etc., while the plant condition is satisfactory. All the criteria bypassed shall be logged and displayed. It shall be possible to put the system on the Auto-mode after operating it on semi-automatic mode for some steps or vice-versa, without disturbance to the sequence operation.

iii) Operator Guide Mode/Test Mode:- It shall be possible to use the sequential control in operator guide mode/ test mode i.e. the complete system runs and receives input from the plant and the individual push button stations (where provided)/ mouse but its command output is blocked. The whole program in this case shall run in manual mode. This mode shall allow the operator to practice manual operation using step and criteria indications. The actual protection should remain valid during this mode of operation also.

5) Complete DM Plant operation shall be through mimics on OWS/LVS. The mimics shall indicate the operating status of different filters, exchange units, pumps, tanks, valves, blowers etc. Colour coding, (as per ENGINEER'S standard coding system which will be furnished) shall be used to differentiate lines for different service such as normal water line, backwash line, rinse line, acid alkali line etc.

6) The system shall have necessary safety system, locking system and manual emergency system. The Safety system for any sequence/step shall check the opening of the required valves and closure of remaining valves of the plant to avoid mal operation. During automatic sequential operation, if any pre-requisite criteria is not fulfilled or is missing for a pre-determined time interval, the steps should not proceed further and an alarm shall be annunciated to let the operator know that the system is blocked.

7) In case of control supply failure, valves of the stream being regenerated shall close automatically and on restoration of supply, further sequence of regeneration shall proceed through operator initiated command.

8) In case of failure of control system, the DM plant valves shall be operated manually by means of manual operator of solenoid valves (as well as by hand wheel of valves) locally.

9) Acid and alkali unloading pumps, agitators of alkali preparation tanks & day tanks and alkali transfer pumps shall have provisions of local start also.

10) Complete stream shall be isolated automatically from SERVICE in case any of the following take place and an alarm displayed.

11) Differential conductivity of the effluent is less or totalised flow and sodium leakage from the cation is high.

12) Conductivity of the effluent or totalised flows from anion is high.

13) Conductivity or silica content of the effluent or totalised flow from mixed bed is high.

14) The operation of alkali/acid inlet valves at ejectors shall be interlocked with the availability of dilution water in the respective ejectors.

15) Common conductivity meter shall be employed for measuring conductivity in the effluent line and rinse lines for anion and mixed bed exchangers. During rinsing of anion and mixed bed unit, the respective analyzer shall be connected to rinse line automatically, in the end of the rinse cycle.

16) During rinsing of mixed bed unit, the analyzer of silica shall automatically be connected to the stream which is under regeneration to ascertain the completion of rinsing operation.

17) Only one stream shall be regenerated at a time. However, all the streams can be put to service simultaneously.

18) The alkali diluent heater shall be controlled by measuring the temperature of water in the heater.

19) For all the pumps, blowers etc. which form part of the automatic operation, facilities through control system shall be provided for Auto/remote manual/Local mode selection wherever specified. Wherever standby equipments are provided, selection of the same shall be possible from the control system. The selected standby equipments shall start automatically in case of failure of working equipment. For, other drives which are not involved in continuous running or automatic operation, facilities through control system shall be provided for remote/local selection.

20) The agitators of the alkali tanks shall be interlocked with the required level in the respective tanks.

21) All the pumps shall be interlocked with the required level in the tanks.

5.07.01 **BACKWASH PIT AND PUMPING SCHEME**

At a specific water level in the sump, selected pump(s) shall start and backwash waste water shall be recycled back to the clarifiers. Upon reaching predetermined low level, one of the operating pumps shall be stopped and further reduction in level shall result into stoppage of all the operating pumps. The pit level shall be available to operator and in case of very high level, the operator shall be alerted to avoid starting of backwash/rinse operation so that the pit do not overflow.

6.00.00 **NEUTRALISATION PIT AND PUMPING SCHEME**

1) At a specific water level in the sump, selected pump (s) shall start and backwash waste water shall be recycled back to the pit and after achieving desired pH level, the waste water shall be pumped out to CMB. Upon reaching predetermined low level, operating pumps shall be stopped and further reduction in level shall result into stoppage of all the operating pumps.

2) The pit(s) level status shall be available to operator and in case of very high level; the operator shall be alerted to avoid starting of regeneration operation so that the pits do not overflow.

7.00.00 **DM PLANT (RO BASED PLANT)**

1) Complete UF+RO+MB combination Plant (Skid mounted) shall comprise of UF skids (2x50%), UF permeate water tanks, automatic type simplex strainers, UF permeate transfer pumps (2W+1S), UF backwash pumps (2x100%), CEB and CIP system complete with tanks and dosing system, micron cartridge filters (3x50%), RO High pressure pumps (3x50%), Complete skid mounted RO blocks (2W+1S) (3x50%), Degasser tower(s), Degassed/RO permeate water storage tanks, RO permeate transfer pumps (2W+1S), RO chemical dosing system consisting of anti-oxidant dosing tanks & pumps, anti-scalant dosing tanks & pumps, RO Chemical cleaning skid (CIP), Mixed bed (MB) exchangers (3x50%) along with regeneration system including acid/alkali unloading Pumps (2x100%), Acid/Alkali storage tanks (2), Acid measuring tanks (2) & Acid/Alkali dosing pumps (2x100%),

Reject disposal system, pumps, blowers, interconnecting piping, fittings, valves etc.

2) For design purpose, minimum feed pressure at inlet of UF shall be considered as 2.5 Kg/cm^2 with feed temperature 10-35 Deg C,

3) CEB system for UF shall be decided by the contractor. However, minimum two (2) nos. of dozing tanks shall be provided along with 2 (2x100%) (1W+1S) dosing pumps for the chemicals envisaged for the system.

7.01.00 **REVERSE OSMOSIS SYSTEM**

1) Each RO stream shall be provided with a dedicated HP pump and one (1) HP pump shall be provided as a store stand-by. The HP pump shall be able to discharge reject against a backpressure without the need for additional pumping equipment. At the discharge side of the HP feed pump a pressure control valve shall be installed to regulate the feed pressure to the membrane assembly according to the salinity of the feed water. The HP pump shall be designed to operate in the entire range of operation of the feed system.

2) Brine leaving the permeate outlet connection at a pressure close to the feed pressure shall be controlled by a flow control valve. The permeate water is discharged to product water system where it is treated for removal of excess CO_2, correction of pH, correction of alkalinity (for Potablisation, if applicable) etc. and stored.

3) Permeate shall be delivered to respective Degassifier thru suck-back arrangement (as applicable)

4) Cleaning and Flushing systems shall be provided for membrane protection. While the cleaning system facilitate cleaning of the fouled membranes and the flushing system flushes the membranes off high TDS water with low TDS water during shutdown operation.

5) Each RO train or stream shall be a self-contained section, with its own feed, brine and product flow control equipment, operable thru control system. Each train /stream shall be cleaned and treated separately, independent of other trains/streams production. Each block (membrane assembly unit) shall be provided with necessary valves and piping to facilitate block wise isolation, monitoring and cleaning facility.

6) A train/stream is composed of one or more blocks (membrane assembly unit) connected in parallel and each block comprise group of modules in parallel. Each RO module is basically cylindrical pressure vessel containing membrane elements. The term element means a single RO membrane element (permeators). Each block (membrane assembly unit) shall be provided with necessary valves and piping to facilitate block wise isolation, monitoring and cleaning facility.

The RO skid shall contain all necessary supports, fixings and clamps required to support the permeators, headers and related piping.

7) Each stream shall be capable of operating either independently or in combination with the other ones. The streams shall be skid-mounted and be furnished complete with all headers and related piping, mounted on the skid. The skid shall contain all necessary supports, fixings and clamps required to support the permeators, headers and related piping. The skid shall be designed to provide ample room for servicing and monitoring the equipment.

8) The removal of a single permeator or a major piece of the equipment must be possible, without removing surrounding equipment. The isolation or removal of an individual permeator for testing or servicing shall be possible while the RO-train is in operation, by means of flexible, self-closing couplings.

9) Stream/train to be divided into certain number of equal blocks which independently can operate facilitating the following advantages:

   i) Repair/maintenance of permeators/pipes/valves and chemical cleaning in a particular block can be carried out without shutdown the whole stream.

   ii) For easier Performance monitoring of permeators, simpler fault identification to render permeators replacement activities easier.

10) Turn Down Capability- One or both the trains shall be operable as per requirement.

7.02.00 **RO MEMBRANE**

1) The Reverse osmosis membrane shall be Polyamide, spiral wound type. The membrane shall be non-telescopic, non-flexing and leak free. Diameter and length shall be as per manufacturer's standard. Average flux rate shall be less than 20 L/M^2h.

2) Number of Membrane (Block) per Train shall be two or more as per design. Number of Membranes per module shall be 6-8.

3) Fouling Allowance for design shall be considered as minimum 5% per year and salt passage increase is minimum 10% per year. End connectors shall be Victaulic coupling (SS) or approved equivalent.

4) The RO membranes shall be supplied from manufacturers well experienced in RO plant design (Brackish water RO) of train/stream capacity comparable that of this project. This shall be demonstrated by the contractor with adequate references of his selected membrane manufacturer(s). Contractor shall furnish design calculation of the RO plant by his preferred manufacturer(s).

5) The membrane system process design shall be provided by the Contractor and such calculation shall be vetted by the membrane manufacturer. The process design shall take into consideration specified fouling allowance and salt passage during the guaranteed (specified) life of the membrane. The process design shall adopt to produce the specified capacity of permeate

with an average flux rate as specified. Further, all the calculations of RO elements shall be justified with the software projections. The membranes shall be supplied from one of the following membrane manufacturers:

DowChemicals-Filmtec/Hydronautics/KOCH/Toray/GE/Approved Equivalent.

6) The average flux rate shall be calculated on the basis of effective membrane area considering standard length & diameter element. Contractor shall ensure that standard Length & diameter of membrane used for design should be available at least three of the above mentioned manufacturers so that during operation stage of the plant, employer may install membranes from other manufacturers. Further, during detail engineering, the contractor shall furnish design calculation from at least three membrane manufacturers to confirm the availability & compatibility of alternate membranes. The design calculation shall furnish data regarding change in parameters of the RO plant such as design net output, recovery, energy consumption etc. in case such alternate membranes are used later by Employer in the Membrane Assembly supplied by Contractor.

7.03.00 **PRESSURE VESSELS**

1) Pressure vessels shall have a diameter and length so as to contain required numbers standard diameter, standard length spiral wound elements.

2) Materials to be selected shall meet the following minimum requirements:

a.	Membranes	As per manufacturer
b.	Pressure vessels	PP or proven material as per manufacturer
c.	End caps or plates:	Non-metallic material of proven Reliability may also be used subject to approval; Fliberglass epoxy as minimum requirement
d.	Segmental rings, to	Corrosion resistant material conforming
	Connectors	SS-316 L or equivalent

3) Details of the design, fabrication, and testing requirements for the pressure vessels shall be in accordance with ASME Section X to allow a code stamp or meet the minimum requirements of ASME Section X.

4) Vessels shall be designed to allow membrane elements to be connected to a permeate port at both ends of the vessel so that permeate can be taken from either ends. The unused pressure vessel permeate port shall be available and piped to permit probing. End closures shall be approved for use in pressure vessel construction to the code requirements.

7.04.00 **HIGH PRESSURE PUMP**

1) The HP feed pump (SS-316) shall be of a centrifugal type. The high-pressure pump shall be designed not to introduce flow and/or pressure pulsation in the feed or brine stream. The reverse osmosis system has to be operated with fluctuating feed salinity and feed temperature. An appropriate regulation of the feed pressure for each reverse osmosis train separately by a corresponding design of the high-pressure pumps with VFD and automatic feed pressure control is required.

2) Energy recovery units permeate booster pumps and associated system may be provided as required. The Contractor shall take care of the concentrate back pressure requirement at downstream of the energy recovery unit as applicable.

3) Selection of parameters (Capacity & Head) of HP Pump, its drive shall take into account requirements of membrane manufacturer and shall be designed to deliver required parameters throughout the design life of membrane. The power consumption to be guaranteed for the HP Pump shall be based on its parameters at the end of guaranteed membrane life.

4) The contractor shall take care of the concentrate back pressure requirement at downstream of the energy recovery unit.

5) The complete unit shall include the pump, motor drive and the lubrication system on a common base plate.

7.05.00 **CLEAN- IN- PLACE SYSTEM**

1) The cleaning system shall be designed for cleaning and sterilizing of in minimum one train of the RO system separately.

2) The RO-plant shall be provided with fixed pipe connections. The flexible couplings from the cleaning pipework to the RO-trains shall be reached from the ground level or sufficient and safe facilities for easy handling of the coupling of the permanently installed cleaning pipework at the RO-racks and the flexible cleaning pipework of the cleaning equipment is to be provided.

3) The cleaning system shall be of skid-mounted type and comprise all necessary equipment for control of the necessary flow rate and pressure during cleaning and enable the recycling of brine and product to the cleaning tank, or alternately, the discharge of these two effluents during the cleaning procedure.

4) The tank volume shall be sufficient to clean in minimum one RO train/stream by utilization of only a single batch of cleaning solution.

5) Sizing considerations also shall include the minimization of batch temperature and variation in solution concentration caused by blending cleaning solution with displaced feedwater contained in the RO permeators.

6) One set cartridge filter (3 micron) shall be provided in the cleaning system to prevent the reintroduction of any insoluble material into the membranes. A temperature control system shall be provided to prevent re-circulated fluid temperature from exceeding the maximum recommended operating temperature of the membrane.

7) The cleaning tanks shall be provided with level measurement for safe operation ie tripping of cleaning system pumps under low water level.

8) For easy, safe and efficient handling of chemicals, a service platform shall be provided if necessary. Sufficient venting equipment also is to be included in the scope of delivery. Sufficient safeguard provisions shall be included, to prevent the accidental over pressurization of cleaning system piping due to inherent interconnections with high pressure RO feed and brine piping.

9) Provisions must be made for the neutralization and disposal of chemical cleaning waste via the brine reject.

10) Two (2x100%) (1W+1S) Chemical cleaning pumps (SS-316), one (1) Cartridge filter (Casing SS-316) shall be provided.

7.06.00 **FLUSHING SYSTEM**

1) Flushing system consisting flushing pumps (2x100%)(1W+1S) (SS-316) shall be provided to enable flush-out of the RO unit stream including HP pump with Low TDS permeate water during shut down of the stream.

2) During flushing the rinse water discharge from the permeator shall be drained into the reject water tanks. The flushing water feed pipeline and the drain lines shall be designed for the high flow rate that is expected during flushing.

3) The flushing water feed lines shall be connected upstream of the each HP pump inlet and the flushing feed line shall be provided with a motorized flush feed valve. The shutdown program shall automatically initiate the flushing feed valve to open and flush the RO train when required.

7.07.00 **SAMPLE PANEL**

a) Each RO unit/train shall be fitted with a fiberglass sample board, which shall be mounted adjacent to the unit. The panel and supports shall have all fiberglass constructions with a minimum 8” wide trough under the sample cocks with 1” PVC drainpipe routed to the trenches. Sample tubing shall be black tubing. The sample panel shall use ¼” SS sample cocks to sample the following

   i) Feed (locate on common manifold)

   ii) Concentrate (locate on common manifold)

   iii) Permeate (locate on common manifold)

   iv) Permeate from each pressure vessel

b) Sample valves shall be SS white snap-action valves and shall be fitted with

plastic nozzles tubes as approved by the engineer.

7.08.00 **DEGASSER SYSTEM**

1) Degasser tower shall be designed to reduce dissolved Carbon-dioxide (CO_2) in treated water. Fill Material of degasser tower shall be Polypropylene or equivalent. Blowers shall be provided to remove CO_2 from water. Degasser tower shall be provided with storage tank to store degassed water. Degasser tower & degassed water tank shall be internally rubber lined of minimum thickness of 4.5 mm and externally painted with epoxy as defined elsewhere. Degassed water pumps shall be provided to supply water to the downstream exchangers in the chain.

7.09.00 **MIXED BED (MB) POLISHER UNITS**

1) Design surface flow rate at design flow shall not be more than 35 $m^3/m^2/hr$

2) Resins-strongly acidic and strongly basic Type-I, both the resin shall be of high capacity polystyrene resins in bead form. Total resin bed depth shall be 1.0 M (min)

3) Two (2x100%) Air-blowers for mixed beds shall be provided.

4) Mixed Bed shall be regenerated after minimum 24 hours of operation followed by regeneration period not exceeding 4 hours.

8.00.00 **UF & RO SYSTEM (CONTROL & OPERATION PHILOSOPHY)**

1) It is not the intent to specify here the complete details of the control system. Basic type of controls required has been specified below. The contractor shall submit the complete detail of the system offered by him like the extent of automation offered, operation of the complete system, logic/flow diagrams, type and details of the presentation of information, the type of mimic, hardware details etc. along with detailed circuit descriptions.

2) Normally drawl of product water (either raw water or DM water) requirement plant shall be from a single tank while the other tanks shall be in filling mode from the RO streams/trains as the case may be. Operation of pumps which draw water from the storage tanks shall be interlocked with the tank level and /or pressure at the suction header, high pressure at the discharge header as the case may be. The field instruments provided by Contractor along with tanks & suction header shall be used for implementation of such logic.

3) It shall be possible by the Operator one or more tanks for drawl mode and other for filling mode. In auto mode, the tank (s) under drawl mode shall switch over to filling mode at a pre-set level in tank and drawl for the plant shall be continued from the tanks which were under filling mode. Upon reaching high level in all the storage tanks, the running streams/trains shall be shut-down in sequence. Similarly the low level in all the tanks shall initiate starting of stream(s) in sequence which are under standby mode/stopped.

4) **POST TREATMENT OF RO**

a) Water flow to degassers shall be interlocked with the level in degassed water storage tanks as well as pH of permeate.

b) Degasser blowers operation shall be interlinked with the operation of associated degasser tower. The standby blower associated with the tower in operation shall come into operation in the event of failure of running blower.

c) The operation of pumps shall be interlocked with the level of the degassed water tank.

d) The performance of respective degasser shall be monitored thru measurement of conductivity & pH of product water.

5) **RO SYSTEM.**

a) RO plant shall be operated and controlled thru control system. All necessary field instruments, analyzers and controls shall be provided by Contractor. Facility for starting and stopping of pumps, selection of stream shall be provided in the control system.

b) The system shall provide the following:

i) Alarms for high permeate conductivity of each skid, Low pH of feed water, High pH of feed water, high feed water temperature, availability of chemical dosing system such as low level in dosing tanks, status of dosing pumps etc.

ii) Continuous monitoring for Feed temperature, Feed pH, conductivity of feed water & permeate, SDI of Feed water, pressure of Feed water, permeate & concentrate, flow of feed water, Permeate & concentrate, residual chlorine of feed water.

c) The HP pumps shall be operated thru control system. Start/ Stop of HP pump shall be interlocked with opening & closing of suction & discharge valves. The pump shall start with its discharge valve closed and on stop/trip command the discharge shall be interlocked to close before the pump stops. Low pressure in the pump suction and high pressure in the pump discharge shall raise an alarm and trip the pump.

d) The operation and control philosophy & instrumentation of Variable Frequency Drive (VFD) and Energy recovery units (ERU) (if applicable) shall be as per the recommendation of the manufacturer.

6) **PERMEATE TRANSFER PUMPS.**

The pump shall be provided with interlocks to trip the pump on Low suction level. The low-pressure signal from pressure transmitter in the discharge header shall start the standby pump, when the system is in auto mode.

a) Motor drives provided with winding temperature measurement & bearing temperature shall sense high & very high temperature for alarm and tripping receptively thru control system.

b) The HP pumps and motor bearings shall be provided with vibration monitoring for measuring vibration levels and vibration “High” and “High-High” alarm shall be annunciated.

c) Additionally HP pump shall be tripped/shutdown under High conductivity in the RO permeate line, high pH in the Feed water line, high feed water temperature, low level in chemical dosing tank, high feed pressure, high differential pressure across permeators, high residual chlorine of feed water, high SDI in feed water and failure of flow control valve,

7) The following control and instrumentation shall be provided in each of the permeator assembly unit:

a) A pressure control valve on the pump discharge line to control feed pressure during operation, during start-up and control salinity during normal operation.

b) Flow control valve on the concentrate line to set the recovery and for ratio control.

c) Conductivity analyzer in permeate and concentrate line to sense, indicate of TDS & salt passage and to derive the recovery of the unit.

d) The RC analyzer signal shall activate an alarm and can used to shutdown the HP pump when chlorine is detected

e) A pressure element transmitter in the permeate line to measure, indicate pressure.

f) pH analyzer in permeate and concentrate lines to sense, indicate pH values.

g) Flow element/transmitter in the permeate line to measure, indicate and provide analysis flow in the permeate line and provide the control signal for the control valve in the concentrate line.

h) Flow element/transmitter in the feed line to measure feed flow.

i) Automatic drain valve/dump valve in the permeate line to provide permeate drain when the TDS in permeate exceed the design limits.

j) Automatic valves in the feed and concentrate lines to connect a clean-in-place and flushing system.

k) Differential pressure element/transmitter mounted with connection on the concentrate brine and feed line to measure, indicate pressure drop in the permeator i.e. to measure severity of fouling.

l) Local Pressure indicator in the feed, concentrate and the permeate

m) Temperature element/transmitter in the feed to measure, indicate and analyze feed temperature.

n) Local Temperature indicators in feed line.

o) Automatic valve on the feed, concentrate and permeate line to facilitate selection/isolation of streams/trains.

p) Sample ports on the feed, concentrate and permeate (to enable evaluation of system performance).

q) Sample port on each pressure vessel permeate outlet to facilitate troubleshooting.

r) Trend analysis shall be possible for various parameters being measured thru instruments as listed above thru control system.

8) **CLEAN-IN-PLACE SYSTEM**

The operation of agitators/mixers of chemical tank can also be initiated manually by means of local start/stop envisaged under DDCMIS, apart from automatic operation. (Option for local/remote control shall be selected through OWS of the control system.) During normal operation mixing shall be automatically started on the initiation of cleaning operation. The cleaning system pumps shall be started during the cleaning cycle progress. The pumps shall be provided with interlocks to trip on low level of chemical tanks. The cartridge filter shall be provided with a differential pressure measurement to monitor the pressure drop across the filter. Selection of RO block/train to be cleaned shall be manual through control system.

9) **FLUSHING SYSTEM**

These pumps shall be selected started and stopped either locally, envisaged under DDCMIS or remotely thru control system (Option for local / remote control shall be selected through OWS of the control system.) During normal operation pump operation shall be automatically started on the initiation of flushing operation. Auto / manual selection switch is provided to select the mode of operation. The pump shall be provided with interlocks to trip the pump on Low suction level. The low-pressure signal from Pressure transmitter in the discharge header shall start the standby pump, when the system is in auto mode. Selection of RO block / train to be flushed cleaned shall be shall be manual through control system.

10) **SUCK-BACK (IF APPLICABLE)**

The operation of suck-back shall be automatic.

9.00.00

A. UF SYSTEM

a) The control & operation of various systems described below is indicative only and the actual control & operation philosophy shall be finalized with during detailed engineering.

b) UF plant shall be operated and controlled thru control system. All necessary field instruments, analysers and controls shall be provided by Contractor. Facility for starting and stopping of pumps, selection of stream shall be provided in the control system.

c) The system shall provide the following:

i) Alarms for, High permeate SDI, availability of chemical dosing system such as low level in dosing tanks, status of dosing pumps etc.

ii) Continuous monitoring for pressure of Feed water, flow of feed water & Permeate.

d) The feed pumps shall be operated thru control system. Start/ Stop of feed pump shall be interlocked with opening & closing of suction & discharge valves The pump shall start with its discharge valve closed and on stop/trip command the discharge shall be interlocked to close before the pump stops. Low pressure in the pump suction and high pressure in the pump discharge shall raise an alarm and trip the pump.

e) The operation and control philosophy & instrumentation of variable frequency drive for UF units (VFD) (If applicable) shall be as per the recommendation of the manufacturer.

f) Also feed pump shall be tripped/shutdown under high feed pressure, high Differential pressure across permeators.

g) The following control and instrumentation are provided in each of the permeator assembly unit :

1. A pressure control valve on the pump discharge line & Flow control valve on the concentrate line to set the recovery in case the contractor's process envisages.
2. SDI analyzer in permeate line to sense, indicate of turbidity
3. Flow element/transmitter in the permeate line to measure, indicate and provide analysis flow in the permeate line.
4. Flow element/transmitter in the feed line to measure feed flow.
5. Automatic drain valve/dump valve in the permeate line to provide permeate drain when the SDI in permeate exceed the design limits.
6. Automatic valves in the feed and concentrate lines to connect CEB and flushing system.
7. Differential pressure element/transmitter

8. Automatic valve on the feed, concentrate and permeate line to facilitate selection/isolation of streams/trains.

9. Sample ports on the feed, concentrate and permeate (to enable evaluation of system performance).

10. Sample port on each pressure vessel permeate outlet to facilitate troubleshooting.

11. Trend analysis shall be possible for various parameters being measured thru instruments as listed above thru control system.

B. FLUSHING SYSTEM

a) These pumps shall be selected started and stopped either locally envisaged under employer's DDCMIS or remotely thru control system (Option for local / remote control shall be selected through OWS of the control system.) During normal operation pump operation shall be automatically started on the initiation of flushing operation. Auto / manual selection switch is provided to select the mode of operation. The pump shall be provided with interlocks to trip the pump on Low suction level. The low-pressure signal from Pressure transmitter in the discharge header shall start the standby pump, when the system is in auto mode. Selection of UF block/train to be flushed cleaned shall be shall be manual through control system.

b) Filter backwash operation shall be initiated whenever head loss across the filter reaches preset point or after specified filtration cycle or at the specified effluent quality of high SDI. The logic to be selected shall be decided by Operator through control system. Upon initiation, filter backwash shall proceed automatically by opening and closure of various valves, starting and stopping of blowers etc. putting the filter stream/trains shall be automatic.

10.00.00 **DATA SHEETS**

10.01.00 **PRE-TREATMENT PLANT**

NO	DESCRIPTION	PT-ACW & Potable System	PT-DM System (Ion Exchange)	PT-DM System (UF+RO+MB)	Coal settling System (CSSP)
I	**INLET PIPE, CONTROL VALVES & ISOLATION VALVES**				
I –A)	**INLET PIPE**				
1)	Material of Construction	Carbon steel			
I –B)	**ISOLATION VALVES**				
1)	Size	---------- Same as that of pipe size ----------			
2)	Type	--------Manually operated Butterfly Valves--------			
II	**AERATOR, STILLING CHAMBER AND INLET CHANNEL**				
II –A)	**Aerator**	**PT-ACW & Potable System**	**PT-DM System (Ion exchange)**	**PT-DM System (UF+RO+MB)**	**Coal settling System (CSSP)**
1)	Type	----------Cascade Type ----------			
2)	Number	One(1)	One(1)	One(1)	-
3)	Material of Construction	RCC	RCC	RCC	-
4)	Design Flow (min.)	2300 m^3/hr.+ 3% for sludge	340 m^3/hr.+ 3% for sludge	220 m^3/hr.+ 3% for sludge	-

NO	DESCRIPTION	PT-ACW & Potable System	PT-DM System (Ion Exchange)	PT-DM System (UF+RO+MB)	Coal settling System (CSSP)
II –B)	**Stilling Chamber**				
1)	Number	One(1)	One(1)	One(1)	One (1)
2)	Material of Construction	---------- RCC ----------			
3)	Type of Construction	----------Circular / Rectangular ----------			
4)	Design Flow (min.)	2300m^3/hr + 3% for sludge	340 m^3/hr + 3% for sludge	220 m^3/hr + 3% for sludge	4800 m3/hr + 3% for sludge
II –C)	**Inlet Channel**				
1)	Number	2	1	1	2
2)	Material of Construction	---------- RCC ----------			
3)	Design Flow (min.)	1150 m^3/hr+ 3% for sludge	340 m^3/hr + 3% for sludge	220 m^3/hr + 3% for sludge	2400 m^3/hr + 3% for sludge
II-D)	**CLARIFIERS**				
1)	Type	---------- Circular Reactor type ----------			
2)	Number	Two(2)	One (1)	One(1)	Two (2)
3)	Design Flow (Net output) (minimum)	1450 m^3/hr	340m^3/hr	220 m^3/hr	2400 m3/hr
4)	Material of Construction	---------- RCC ----------			
5)	Material of pipe from Inlet channel to	Carbon steel pipe encased with concrete for buried portion and externally epoxy painted inside the			

NO	DESCRIPTION	PT-ACW & Potable System	PT-DM System (Ion Exchange)	PT-DM System (UF+RO+MB)	Coal settling System (CSSP)
	clarifier	clarifiers			
6)	**Sludge Blow-off to Sludge Sump**				
	a) Type	---------- By gravity ----------			
	b) Pipe material	---------- C I Class A as per IS : 1536 ----------			
	c) Constant Bleed arrangement with telescope device	---------- Required ----------			
	d) Flushing connection	---------- Required ----------			
7)	**Reaction Turbine**	With variable frequency drive as per Manufacturer's Standard			
8)	**Clarifiers Scrappers**				
	a) Number	--------One (1) assembly per Clarifier --------			
	b) Material of construction	----------Mild steel with rubber inserts ---------- (with bitumastic paint protective coating)			
	c) Drive	Slow speed Motor driven through reduction gear unit or variable frequency drive as per manufacturer's standard			
9)	**Overflow Weir/Notch**				
	Location	--To be fixed in the radial launders of Clarifier---			
	Material	--------- Mild steel/RCC ---------			

10.02.00

GRAVITY FILTERS

NO	DESCRIPTION	PT-DM System (Ion Exchange)	PT-DM System (UF+RO+MB)	PT-Potable water System
I)	**GRAVITY FILTERS**			
1)	Type	Twin Section	Twin Section	Twin Section
2)	No. of filters	2	2	2
3)	Design flow per gravity filter (net output)	170 m^3/hr.	220 m^3/hr.	100 m^3/hr.
4)	Maximum flow per gravity filter	170 m^3/hr+2%	220 m^3/hr+2%	100 m^3/hr+2%
5)	MOC	---------- R.C.C. ----------		
6)	Surface medium	-------- Anthracite/ Sand --------		
7)	Filter Flow rate at max. flow rate	---Not more than 5m^3/m^2/hr. ---		
8)	Supporting material	---------- Graded Gravel -------		
9)	**Air Scour Blowers**			
	i) Number of blowers	3 Nos. (2W+1S) each		
	ii) Type	Rotary Twin lobe / centrifugal		
	iii) Capacity of each blower & head	As required		
	Material of Construction			
	1) Casing, cover & stator	Cast Iron IS:210 Gr.FG 260		
	2) Impeller/Lobe	Cast Iron IS :210 Gr. FG 260		
	3) Shaft	Carbon steel BS:970 En-8/ANSI-I045		

NO	DESCRIPTION	PT-DM System (Ion Exchange)	PT-DM System (UF+RO+MB)	PT-Potable water System
II)	**OVERHEAD FILTERED WATER STORAGE TANK (Roof of Chemical House)**			
1)	Number	----------One (1) ----------		
2)	Material of Construction	---------- RCC ----------		
3)	Effective Capacity	-----Not less than 300 Cu.M --------		
4)	**Float operated level control valve**			
	Number & Size	One No. (1) same as that of line size		
	Type	Angular (Stem & lever operated) rubber seated valve		
	Material of Construction			
	a) Body & Bonnet	----------Cast Iron ----------		
	b) Float	---------- Copper / Brass ----------		
	c) Stem	----------SS-304 ----------		

10.03.0 **CLARIFIED WATER STORAGE TANK/SLUDGE/ BACKWASH WATER PIT /SUMP**

I	**CLARIFIED WATER STORAGE TANK/DISTRIBUTION CHAMBER (ABOVE GROUND)**	
1)	Number of Storage tank	One (1)
2)`	Capacity	Not less than 600 Cu.m
3)	Material of Construction	RCC with cover
II	**SLUDGE PIT/SUMP & PUMP HOUSE (COMMON)**	
1)	Number of Sludge pit	One(1) in two (2) sections

2)	Effective capacity of each section	Not less than 100 Cu.m
3)	Material of Construction	RCC
4)	Sludge Pump house	
	a) Number	One(1)
	b) No of pumps	As specified
5)	Air Scour Blowers	2 nos (1W+1S),
6)	Capacity and head.	As reqd.
IV	**BACKWASH WATER PIT/SUMP & PUMP HOUSE (COMMON FOR PT-DM & PT-POTABLE)**	
1)	Number of pits	One(1) in two(2) sections
2)	Effective capacity each section	Not less than 150 Cu.M
3)	Material of Construction	RCC with Acid alkali proof lining
4)	Backwash water Pump house	
	a) Number	One (1)
	b) No of pumps	As specified
	c) Type of pump	--Vertical, non-clog, Sump pumps --
	d) Type of Working Fluid	-Drains with particle size up to 40 mm -
	e) Type of impeller	---------- Open ----------

10.04.00 **Pumps**

A) Vertical Sump Pumps			
NO	**DESCRIPTION**		**Waste Service Water Transfer Pumps, Sludge Pumps, Filter back wash pumps**
1)	Operating Speed (Maximum)	:	----------1500 rpm----------

A) Vertical Sump Pumps

NO	DESCRIPTION		Waste Service Water Transfer Pumps, Sludge Pumps, Filter back wash pumps
2)	Pumps & Drives to be designed for	:	---------- Outdoor Duty ----------
3)	Service of duty	:	---------- Continuous ----------
4)	Type of pump	:	------Vertical, non-clog, Sump pumps -------
5)	Type of Working Fluid	:	Untreated drain water
6)	Type of Discharge	:	---------- Above Floor discharge ----------
7)	Type of impeller	:	---------- Open ----------
8)	Type of lubrication	:	---------- Grease ----------
9)	Suction condition	:	---------- Submerged ----------
10)	Minimum Water level	:	----------By Bidder ----------
11)	Maximum Water level	:	-------- Local Finished Grade level----------
12)	Operating floor level	:	----------Minimum 500 mm above FGL-------
13)	Type of shaft coupling	:	----------Flexible / Rigid ----------
14)	**Material of Construction**		
	a) Suction Bell /Casing	:	2.5 % Nickel Cast Iron, IS:210 Grade FG 260; S-0.1% max. P-0.15% max.
	b) Impeller	:	ASTM A351 CF8M
	c) Shaft	:	---------- SS-410 ----------
	d) Shaft coupling	:	---------- SS-410 ----------
	e) Shaft sleeves	:	---------- SS-410 ----------
	f) Column pipe & Discharge pipe	:	CS as per IS: 2062 or Eq.
	g) Shaft enclosing	:	----------do ----------

A) Vertical Sump Pumps			
NO	**DESCRIPTION**		**Waste Service Water Transfer Pumps, Sludge Pumps, Filter back wash pumps**
	tube(if applicable)		
	h) Stuffing box	:	2.5 % Nickel CI,IS:210 Grade FG 260;
	i) Gland	:	2.5 % Nickel CI,IS:210 Grade FG 260;
	j) Gland packing	:	----------TIWA ----------
	k) Gaskets	:	---------- Neoprene Rubber ----------
	l) Bolts & nuts	:	Stainless steel for those coming in contact with water and for others, material shall be high tension carbon steel.
	m) Base plate and Soleplate	:	Carbon steel (Minimum 10 mm thick)

B. Vertical Turbine (Wet pit) Type Pumps			
NO	**DESCRIPTION**		**Potable Water Pumps (Colony), Potable Water Pumps (Plant), Coal Decanted Water Pumps, Filter water Pumps, Clarifier feed pumps (CSSP area)**
1)	Operating Speed (Maximum)	:	---------- 1500 rpm ----------
2)	Pumps & Drives to be designed for	:	----------Outdoor Duty ----------
3)	Service of duty	:	----------Continuous ----------
4)	Type of pump	:	Vertical wet pit, and non-pull out type.
5)	Type of Working Fluid	:	Decanted , filter water

6)	Maximum water temperature	:	36 deg C
7)	Minimum water temperature	:	25 deg C
8)	Type of Discharge	:	----------Above Floor discharge ----------
9)	Type of impeller	:	----------Closed / Semi-open ----------
10)	Type of lubrication	:	----------Self water or grease ----------
11)	Suction condition	:	----------Submerged ----------
12)	Minimum Water level	:	---------- By Bidder ----------
13)	Maximum Water level	:	--------Local Finished Grade Level (FGL) -----
14)	Sump Invert level	:	---------- As per design ----------
15)	Operating floor level	:	----------Minimum 500 mm above FGL ---------
16)	Type of shaft coupling	:	----------Flexible / Rigid ----------
17)	**Material of Construction :**		
i)	Suction Bell	:	2.5%NiCI; IS: 210Gr FG 260; S-0.1%&P-0.15% max.
ii)	Casing / Bowl	:	2.5%NiCI;IS:210Gr FG 260;S-0.1%&P-0.15% max.
iii)	Impeller	:	ASTM A351 CF8M
iv)	Wearing rings (if applicable)	:	----------As per manufacturer's Std ----------
v)	Impeller Shaft, Pump & line shaft	:	----------SS ASTM A 276 Gr. 410. ----------
vi)	Shaft coupling	:	---------- SS ASTM A 276 Gr. 410 ----------
vii)	Shaft sleeves	:	----------SS - ASTM –A 276 – 410 ----------
viii)	Shaft bearings	:	Cutless rubber with bronze retainer for bearings below minimum water level and Thordon type bearing for bearings above minimum water

			level.
ix)	Column pipe	:	Fabricated steel as per IS: 2062 (minimum thickness shall not be less than 8 mm) with 2 coats of epoxy coating inside & outside.
x)	Shaft enclosing tube	:	---------- Not Applicable ---------
xi)	Discharge Head	:	Fabricated steel as per IS:2062 (minimum thickness shall not be less than 8 mm) or Cast Iron with 2 coats of epoxy coating inside and outside.
xii)	Distance piece (if applicable)	:	Fabricated steel as per IS:2062(minimum thickness shall not be less than 10 mm) with 2 coats of epoxy coating inside.
xiii)	Matching flanges	:	Fabricated steel as per IS:2062
xiv)	Stuffing box	:	2.5% NI-CI to IS:210 FG-260
xv)	Gland	:	2.5% NI-CI to IS:210 FG-260
xvi)	Gland packing	:	Impregnated TEFLON
xvii)	Gaskets	:	Wire reinforced rubber gasket / Neoprene rubber / Compressed Asbestos Fiber
xviii)	Bolts & nuts	:	Stainless steel AISI type 304/316 for those coming in contact with water and for others, material shall be high tension carbon steel.
xix)	Base plate and Soleplate	:	Fabricated steel as per IS : 2062
xx)	Accessories to be provided with each pump	:	a) Companion flanges with nuts, bolts and gaskets, Positioning dowels, Eye bolts, lifting etc b) Internal piping with valves filters & Instruments for sealing/ cooling/ lubrication system upto and including isolating valve etc as per requirement. c) Non –reverse ratchet shall be provided as per manufacturer's standard practice.
24	Other Technical	:	Refer sub-section titled "Vertical turbine pumps in ACW System in Part-B of Technical

	Requirements		Specification

C.	Horizontal Centrifugal pumps					
NO	**Designation**	**:**	**Chlorine water booster pumps for ACW and PT**	**Lime Slurry Transfer Pumps**	**Lime Dosing Pumps**	**Transfer pumps in distribution chamber in CSSP (if applicable)**
1)	Operating Speed	:	----------1500 rpm (max) --------- ----3000 rpm (max) (Chlorine water booster pumps) --			
2)	Pumps and drives to be designed for	:	----------Outdoor Duty ----------			
3)	Service of duty	:	----------Continuous ----------			
4)	Type of pump casing	:	---------- Radially Split type ----------			
5)	Type of Working Fluid	:		Lime Solution (10% v/v)	Lime Solution (6% w/v)	
6)	Maximum water temperature	:	45 deg C	80 deg C	80 deg C	45 deg C
7)	Minimum water temperature	:	33 deg C	40 deg C	40 deg C	33 deg C
8)	Type of lubrication	:	----------Grease ----------			
9)	Suction condition	:	----------Flooded suction ----------			
10)	**Material of Construction :**					

i)	Casing	:	ASTM A351 CF8M	2.5% Ni CI IS210 Gr FG 260	2.5% Ni CI IS210 Gr FG 260	ASTM A351 CF8M
ii)	Impeller	:	ASTM A351 CF8M	ASTM A351 CF8M	ASTM A351 CF8M	ASTM A351 CF8M
	Wearing rings (if applicable)	:	SS – 316	SS – 316	SS – 316	SS – 316
iii)	Shaft	:	SS-410	SS-410	SS-410	SS-410
iv)	Shaft sleeves	:	SS- 410	SS- 410	SS- 410	SS- 410
v)	Stuffing box	:	---------- 2.5% Ni CI IS210 Gr FG 260 --------			
vi)	Gland	:	---------- 2.5% Ni CI IS210 Gr FG 260 --------			
vii)	Bolts & nuts	:	Stainless steel for those coming in contact with water and for others, material shall be high tension carbon steel.			
viii)	Base plate	:	----------Carbon steel ----------			
21	Accessories to be provided with each pump	:	a) Companion flanges with nuts, bolts and gaskets, Internal piping with valves filters & Instruments for sealing/ cooling/ lubrication system upto and including isolating valve etc, b) Positioning dowels, drain plugs, vent valve etc c) Coupling guards, Eye bolts, lifting etc.			
22	Other Technical Requirements	:	**Refer sub-section titled "Horizontal Pumps" in ACW Chapter Part-B of Technical Specification**			

D.	**METERING PUMPS – ALUM DOSING PUMPS**				
No	**Designation**	**:**	**PT-CW System**	**PT- DM System**	**Tube settlers/Lamella Clarifiers**
1)	Type	:	---------Simplex hydraulically operated Diaphragm type -----		

2)	Capacity (minimum)	:	As per design	As per design	As per design
3)	Head	:	As required	As required	As required
4)	Liquid to handled and concentration	:	---------- Alum solution 10% W/V ----------		
5)	Capacity control	:	10 --100% of capacity manually by micrometer dial		
6)	Pump stroke speed per minute	:	---------- Maximum 100 ----------		
7)	**Material of Construction:**				
	a) Liquid end (pump head valve, valve housing, etc) ,valve spring	:	----------AISI -316 ----------		
	b) Diaphragm	:	---------- PTFE ----------		
	c) Packing	:	---------- PTFE ----------		
	d) Shaft	:	--- Hardened steel EN8-BS-970)/ AISI-316 ---		
8)	Accessories	:	Pressure Dampeners, Safety Relief valves etc. required		

E.	**Drainage Pumps**		
NO	**DESCRIPTION**		**PARAMETERS**
1)	Designation	:	**Drainage Pumps (Miscellaneous)**
2)	Location	:	For dewatering of various pits/sumps
3)	Total Number of Pumps	:	Twelve (12)
4)	Flow of each pump	:	40 Cu.M/h
5)	Total head	:	20 MWC

6)	Operating Speed	:	----------Max 1500 rpm----------	
7)	Pumps & Drives to be designed for	:	---------- Outdoor Duty ----------	
8)	Service of duty	:	---------- Intermittent----------	
9)	Type of pump	:	Submersible type fixed inside pits/ sump with guides /lifting chains	Submersible & Portable type;
10)	Type of Working Fluid	:	----Drains with particle size upto 40 mm---	
11)	Type of impeller	:	---------- Open ----------	
12)	Type of lubrication	:	----------Self / Grease / Oil ----------	
13)	**Material of Construction :**			
	a) Casing	:	2.5 % Nickel Cast Iron, IS: 210 Grade FG 260, S-0.1% max. P-0.15% max.	
	b) Impeller	:	---------- SS-316 ----------	
	c) Shaft	:	---------- SS- 410 ----------	
	d) Bolts & nuts	:	---------- SS-316 ----------	
14)	Accessories to be provided with each pump	:	Suction Strainer, Trolley, Discharge hose (at least 30 m), Adaptors for discharge flange, Level Switches/ Controllers, Water proof cables (50 m) Lifting hook & chain etc.	
15)	Other Technical Requirements	:	Refer subsection titled "Submersible Pumps" in ACW Chapter of Part-B of Technical Specification	

10.05.00 **CHEMICAL HOUSE EQUIPMENTS ~~AND CHLORINATION PLANT~~**

A.	**CHEMICAL HOUSE EQUIPMENTS**	
I)	**Weighing Scales**	
1)	Type	Platform & Dial type/Electronic type

2)	Number & Capacity		One of 0-500 Kg & One of 0-2000 Kg	
II)	**Monorail hoist**			
1)	Type		Electrically operated	
2)	Number and Capacity		Two numbers each of 2 Ton capacity	
III)	**Chemical Tanks**	**Lime Slaking Tanks**	**Lime Solution Preparation Tanks**	**Alum Solution Preparation Tanks**
1)	Number	As specified		
2)	Material of construction	RCC (With 2 coats of Bitumastic paint over 2 coats of primer)		RCC (With Acid/Alkali resistant tiles)
3)	Agitator & Number	Motor driven with reduction gear unit ; One(1) per tank		
4)	Dissolving Chamber for each tank	----------Required (Stainless steel Material) ------		
5)	Agitator shaft matl.	---------- SS -316 ----------		
6)	Agitator Impeller matl.	---------- SS-316 ----------		
B	**CHLORINATION PLANT /EQUIPMENTS**			
I)	**Chlorine Ton Containers**		**ACW– Chlorination**	**PT-Chlorination**
1)	Number		20	8
2)	Chlorine capacity in each Ton Containers		---------- Not less than 900 Kg --------	
3)	Mounting arrangement		Chlorine tonner mounted on two numbers of metallic brackets each provided with two (2) roller supports	
II)	**Evaporators (For ACW System)**			

1)	Number required	2 Nos.	Not Applicable
2)	Type	Electrically heated constant temperature water bath type	Not Applicable
3)	Capacity	50 Kg/hr	Not Applicable
4)	Material of Construction		
	i) Vaporiser Body	Seamless steel tubes as per ASTMA –106 Gr. B	Not Applicable
	ii) Flanges	IS : 2002 Gr. 'B'/Equiv.	Not Applicable
5)	Cathodic protection system to protect water bath tank and outside of evaporator	Required	Not Applicable
6)	Hydraulic Test Pressure for vaporiser	40 Kg/cm^2	Not Applicable
7)	Electrically interlocked shut off valve at the gas discharge line from evaporator	Required	Not Applicable
8)	One (1) No Control cubicle containing necessary contactors, fuses, ammeters and other instruments for each evaporator.	Mounted near the evaporator	Not Applicable
III)	**Strainers**		
1)	Number required	Two (2x100%) for each Chlorinator (1 W+1 S)	Two (2x100%) for each Chlorinator (1 W+1 S)
IV)	**Chlorinators**		
1)	Number required	Two (2) (1W+1S)	Two (2) (1W+1S)

2)	Capacity of each Chlorination	50 Kg/hr.	20 Kg/hr.
3)	Type	----Vacuum operated solution feed type--	
4)	Inlet chlorine pressure reducing valve	Required	
5)	Chlorine feed rate adjuster	Required	
6)	Automatic pressure vacuum relief valve	Required	
V)	**Chlorinated Water Diffuser & Mixing System**		
1)	Chlorinated water supply point	As per system requirement	Before aerator, in the stilling chambers & filtered water sump of potable water system
2)	Location of diffusers	----As per system requirement ----	
3)	Material of construction	---Rubber lined perforated Steel tubes --	
VI)	**Hoist**		
1)	Type	Electrically operated	
2)	Number	One (1)	One (1)
3)		In case Chlorination system is envisaged under common building, one (1) no of electrically operated overhead travelling (EOT) crane may be provided.	
4)	Capacity	Each of 2 Ton capacity with lifting beams & load indictor.	
VII)	**Weighing Scale**		
1)	Type	Electronic type	
2)	Number & Capacity	Two (02) Number; 2 Tonne each	
VIII)	**Chlorine Leak Absorption**	**ACW-**	**PT-Chlorination**

	System	**Chlorination**	
1)	Type	----------Automatic----------	
2)	Blowers		
	i) Number	2 nos. (1W + 1S)	2 nos. (1W+1S)
	ii) Type	----------Centrifugal----------	
	iii) Fluid Handled	Air with chlorine gas/Caustic solution	
	iv) Location	----------Outdoor----------	
	vi) Capacity & discharge pressure	----------As required ---------	
	vii) Material of construction	Blower internals i.e. casing, impeller, shaft etc. shall be FRP lined to protect against corrosion	
3)	**Absorbent Circulating Pumps**		
	i) Number	2 Nos. (1W+1S)	2 Nos. (1W+1S)
	ii)Type	-------Horizontal Centrifugal Type--------	
	iii) Fluid Handled	---Sodium Hydroxide (20% Conc.)---	
	iv) Capacity (minimum) and Head	20 M^3/hr; Head to suit system requirement	
	v) Material of Construction		
	a) Casing	ASTM A 351 GR CF8M	
	b) Impeller	ASTM A 351 GR CF8M	
	c) Shaft	SS 410	
	d) Shaft Sleeve	SS 410	
4)	**Caustic Solution Tank**		
	i) Number	One (1)	One (1)
	ii) Type	Cylindrical conform to ASTM 3199/BS -	

		4994	
	iii) Useful Capacity	6 Cu.M or capacity required of to neutralize one ton of chlorine whichever is maximum	
	iv) Material	----------FRP + PP----------	
	v) External Protection	---------As specified --------	
	vi) Vent, Overflow, drain connection	---------- Required ----------	
	vii) Dissolving basket	---------- AISI-316 ----------	
5)	**Absorber Tower**		
	i) Number	One (1)	One(1)
	ii) Type	Cylindrical conform to ASTM 3199/BS - 4994	
	iii) Resin	Isopthalic type suitable to corrosion resistant to sodium Hydroxide (20% Concentration) & Moist chlorine vapour	
	iv) Reinforcement material	----------Glass fibre Class C----------	
6)	Isolation Dampers		
	i) Type	----Manual /Electric motor actuated-----	
	ii) fluid Handled	Moist air chlorine mixture/Air caustic solution mixture	
	iii) Location	-----Motorised dampers – outdoor-------- --------Manual damper – inside----------	
	iv) Material of Construction		
	i) Casing, Disc, Shaft and Pins/ Keys	--------To suit fluid handled----------	
	ii) Bearings	----------Teflon----------	
	iii) Disc Seal	----Asbestos – impregnated Teflon-------	

7)	Hood for Ton Container	
	i) Type of material	----------FRP----------
	ii) Quantity	One hood per container in two halves for all the connected containers
IX)	**Safety & Supervisory Equipment**	
1)	Number of Gas Masks & air breathing equipment required	6 sets for ACW system 4 sets for PT System
2)	Number of Chlorine Sensors	
	a) For Connected Cylinders (integrated with Chlorine leak absorption system)	Refer tender drawing titled "Schematic diagram of Chlorination Plant".
	b) For Other areas i) Tonner Storage (Unconnected) ii) Evaporators & Chlorinators area	Minimum 2 nos Minimum 1 no for each room
3)	Emergency Kits	
	Numbers Required	Four (4) numbers along with flexible hose of 50M (approx.)
C)	**Waste Service Water Treatment System**	
I)	**Sumps/ Tanks**	**Waste Service water sump**
1)	Number of service Water Sump /Tank	One(1) in two(2) sections
2)	Effective capacity of each section	Not less than **250** Cu.m
3)	Material of construction	----------RCC ----------
4)	Oil skimmer	Required with an oil drum for collection of oil
5)	Oil Centrifuge	Required
6)	Waste/Treated Service Water	3x100%

	Pumps	
II)	**Tube settlers/ Lamella clarifiers**	
	i) Numbers	2
	ii) Design Flow (net output)	Not less than **250** Cu.m/hr
	iii) Material of Construction	RCC
	iv) No of Flash Mixer	One(1) with required agitator
	v) Material of Construction of Agitator	SS-316
D)	**Treated/Service Water System**	
I)	**Tanks**	
1	Number of Treated/Service Water Tank	One(1) in two(2) sections
3	**Material of construction**	----------RCC ----------
4	Waste / Treated Service Water Pumps	As specified
E)	**Coal Handling Plant Run-Off Water Treatment System**	
1)	Number of Coal Slurry Settling Ponds (CSSP)	Four(4)
2)	Material of Construction	RCC
3)	Total Design Flow of CSSP	As specified
4)	Capacity of each pond of CSSP	As specified
5)	**Coagulant Aid Solution Tanks**	
	i) Numbers	Two (2) with slow speed agitators
	ii) Type	Vertical cylindrical with dished end bottom & with cover at the top.
	iii) Effective Capacity of each tank	1.0 Cu.M (Minimum)

	iv) **Material of Construction**	Carbon steel internally rubber lined and externally painted with epoxy painting.
	a) Agitator & Number	Motor driven with reduction gear unit One(1) per tank
	b) Agitator shaft, impeller	SS -316
	c) Type of Dosing	By gravity/pumping from the tank in the inlet channel
7)	**Coal decanted sumps**	
	i) Number of Sump	One(1) in two (2) sections
	ii) Effective capacity of each section	Not less than **500** Cu.m
	iii) Material of construction	----------RCC ----------
	iv) Coal decanted water pump	As specified
8)	**Lime Slacking tank**	
	a)Numbers	Three (3) with slow speed agitators
	b)Effective Capacity of each tank	As per design.
	c) Material of Construction	RCC
	d) Agitator & Number	Motor driven with reduction gear unit One(1) per tank
	e) Agitator shaft, impeller	SS -316
9.	**Lime solution Preparation tank**	
	a)Numbers	Three (3) with slow speed agitators
	b)Effective Capacity of each tank	As per design.
	c)Material of Construction	RCC
	d) Agitator & Number	Motor driven with reduction gear unit One(1) per tank

	e) Agitator shaft, impeller	SS -316
10	**Alum solution Preparation tank**	
	a)Numbers	Four (4) with slow speed agitators
	b)Effective Capacity of each tank	As per design.
	c)Material of Construction	RCC
	d) Agitator & Number	Motor driven with reduction gear unit One(1) per tank
	e) Agitator shaft, impeller	SS -316
11.	**Synthetic Flocculent tank**	
	a)Numbers	Three (3) with slow speed agitators
	b)Type	Vertical cylindrical with dished end bottom & with cover at the top.
	c)Effective Capacity of each tank	As per design.
	d)Material of Construction	Carbon steel internally rubber lined and externally painted with epoxy painting.
	e) Agitator & Number	Motor driven with reduction gear unit One(1) per tank
	f) Agitator shaft, impeller	SS -316
	g)Numbers	Two (2) with slow speed agitators
F)	**Distribution Chamber (Above ground)**	
1)	Number of Basin	One(1) number in twin sections
2)	Material of Construction	RCC
3)	Capacity of each section	500 Cum (minimum)

G).	**Chemical (Lime) tanks for neutralization**	
	a) Numbers	Three (3) with slow speed agitators
	b) Effective Capacity of each tank	As per design.
	c) Material of Construction	RCC
	d) Agitator & Number	Motor driven with reduction gear unit One(1) per tank
	e) Agitator shaft, impeller	SS -316
H)	**Central Monitoring Basin (Above Ground)**	
1)	Number of Basin	One(1) number in twin sections
2)	Material of Construction	RCC
3)	Waste water RO Effluent Pumps	As specified

11.00.00 **ION EXCHANGER UNIT (CATION EXCHANGERS, ANION EXCHANGERS AND MB UNITS)**

I	**DM PLANT STREAMS**	
1)	Stream Capacity	160 Cum/hr
2)	Number of Streams	Two (2)
III	**ACTIVATED CARBON FILTER**	
1)	Type	Vertical shell type with dished ends
2)	Number of units per stream	One (1)
3)	Design Flow per unit (Net)	160 CuM /hr
4)	Period between two (Design) successive back wash	24 hours
5)	Design surface flow at design flow (maximum)	15 M^3/hr/M^2

I	**DM PLANT STREAMS**	
1)	Stream Capacity	160 Cum/hr
2)	Number of Streams	Two (2)
III	**ACTIVATED CARBON FILTER**	
6)	Design Pressure of Vessel (minimum)	8 Kg/Sq.cm (g)
7)	Filter Media / Resin	Activated Carbon
8)	Minimum bed depth of filter media/ Resin	1200 mm
9)	Supporting material for the fill	Graded gravel
10)	Shell & dished end material	Mild Steel as per specified code
11)	Internal painting	Epoxy Paint
12)	External painting	Chlorinated Rubber Paint
13)	Number of Manhole per Vessel	Minimum Two (2)
14)	Number of Sight windows with minimum clear width of 75 mm	Minimum Two (2)

II	**ION EXCHANGER UNITS**	Weak Acid Cation Unit	Strong Acid Cation Unit	Weak base Anion Unit	Strong base Anion Unit	Mixed Bed unit
1)	Type	-Vertical shell type with torispherical dished ends -				
2)	Number of Streams	Two (2)		Two (2)		Two (2)
3)	Number of units per DM stream	----------One (1)----------				
4)	Design Flow per unit (Net) in Cu.m/hr	160				
5)	Guaranteed Effluent Quality	As specified elsewhere				

II	ION EXCHANGER UNITS	Weak Acid Cation Unit	Strong Acid Cation Unit	Weak base Anion Unit	Strong base Anion Unit	Mixed Bed unit
6)	Period between two (Design) successive regenerations in hours	12		12		108
7)	Design surface flow at design flow (maximum)	As specified elsewhere				
8)	Resin	Strongly acidic, high capacity polystyrene resin in bead form		Strong base, Type-I, high capacity polystyrene resin in bead form		Strongly acidic and Strongly basic Type-I resins. Both resins of high capacity polystyr-ene resins in bead form.
9)	**Resin Depth**					
a)	Minimum bed depth of Resin for Counter current.	------ 1000 mm -------				--------
b)	Minimum bed depth of filter Resin for Co-current.	-------- 800 mm -------				--------
c)	Minimum (Total) bed depth of Resin over bed plate/header lateral	----------				1000 mm
10)	Shell & dished end material	---Mild Steel as per specified code -----				
11)	Design Pressure of Vessels	---------- 8 Kg/Sq.cm (g) (minimum) ----------				

II	ION EXCHANGER UNITS	Weak Acid Cation Unit	Strong Acid Cation Unit	Weak base Anion Unit	Strong base Anion Unit	Mixed Bed unit
12)	Shell (Internal) lining Material & Thickness	-----Rubber & minimum 4.5 mm (thick) ----				
13)	External painting	----------Chlorinated Rubber Paint ----------				
14)	Regeneration	By HCl		By NaOH		By HCl & NaOH

12.00.00 DEGASSER SYSTEM

A	**DEGASSER TOWERS**	
1)	Number of units per DM stream	One(1)
2)	Type	Forced draft type
3)	Design Flow per unit (Net) in Cu.m/hr	160
4)	Fill Material	Polypropylene or equivalent
5)	Shell material	Mild Steel as per specified code
6)	Shell (Internal) lining Material & Thickness	Rubber & minimum 4.5 mm
7)	External painting	Epoxy Paint
B	**DEGASSED WATER STORAGE TANK**	
1)	Type	Horizontal cylindrical atmospheric with dished ends
2)	Design Standard (for diameter, length & thickness)	As per BS: 2594. However, dished ends shall be of Torispherical type
3)	Number of units per DM stream	One (1)

A	**DEGASSER TOWERS**	
1)	Number of units per DM stream	One(1)
4)	Useful (Effective) Capacity (minimum)	70 CuM
5)	Shell material	Mild Steel as per specified code
6)	Shell (Internal) lining Material & Thickness	Rubber & minimum 4.5 mm
7)	External painting	Epoxy Paint

C	**DEGASSED WATER PUMPS**	
1)	Location	Near Degasser Units
2)	Working Fluid	De-cationised water
3)	No of pumps	Three (3) (3x100%)
4)	**Material of Construction**	
	i. Casing , Impeller	------ASTM A CF 8M -----
	ii. Shaft, shaft sleeves, Coupling	SS- 410
	iii. Wearing rings (if applicable)	SS -316

D	**BLOWERS**	**For Degasser Units**	**For Mixed Bed Units**
1)	Type	Centrifugal	Centrifugal/Twin lobe type
2)	Numbers required	Two (2) per Degasser unit	Two (2) (1W+1S)
3)	Duty	Continuous	Intermittent
4)	Capacity of each Blower	100% requirement of one (1) degasser tower	As required
5)	Head	-------As required-----	

A	**DEGASSER TOWERS**	
1)	Number of units per DM stream	One(1)
6)	Maximum Speed of Blower	1500 rpm
7)	MOC	As per mfr. Std.

13.00.00 BRINE PREPATION & PUMPING SYSTEM

A	**Brine Solution Preparation Tank**	
1)	Number	One(1)
2)	Material of construction	Mild steel (Internally rubber lined and externally painted with epoxy paint)
3)	Effective Capacity	3 Cu.M
4)	Dissolving basket Material	SS -316.
5)	Agitator Material	SS-316
B	**Brine Solution Transfer Pumps**	
1)	Number	Two (2x100%) (1W+1 S)
2)	Type of Pump	Horizontal Centrifugal
3)	Fluid Handled	Brine (Solution of NaCl and NaOH)
4)	Capacity	10 Cu.M/hr
5)	Head	15 mWC (minimum)
6)	Duty	Intermittent
7)	Material of Construction of pump	SS -316

14.00.00

A. REGENERATION (CHEMICAL HANDLING/UNLOADING & STORAGE) SYSTEM

A) Chemical Unloading Pumps		Acid	Alkali
1)	Duty	Intermittent	Intermittent
2)	Numbers required	As specified	As specified
3)	Material of Construction		
	i) Casing, impeller, wearing rings	PP	SS-316
	ii) Shaft, shaft sleeve	PP/ EN-8, Mfg. std.	SS-316
	iii) Sets of Hoses with coupling & Diaphragm type Isolation Valves	Material of Hose: Chemical resistant, UV inhibited PVC	
3)	Number/Length of Sets Required	Two (2) - 30 meters (minimum)	

B. REGENERATION STORAGE, CHEMICAL PREPARATION & DOSING SYSTEM

A) Bulk Storage Tanks		Acid	Alkali
1)	Type	Horizontal Cylindrical atmospheric with dished ends	Horizontal Cylindrical atmospheric with dished ends
2)	Design Standard (for diameter , length & thickness)	As per BS: 2594. However dished ends shall be of Torispherical type	As per BS: 2594. However dished ends shall be of Torispherical type
3)	Numbers required	As specified	As specified
4)	Liquid to be handled	HCl 30-33% Conc.	NaOH 48% Conc.
5)	Useful (Effective)	To store 30 days requirement, However	To store 30 days requirement, However

A) Bulk Storage Tanks		Acid	Alkali
	Capacity	capacity of each tank shall be 50 Cu.M minimum.	capacity of each tank shall be 50 Cu.M minimum.
6)	Shell material	Mild Steel	
7)	Shell (Internal) lining Material & Thickness	Rubber Lining (4.5 mm Thick)	

B) Alkali transfer cum recirculation Pumps		
1)	Type	Horizontal Centrifugal
2)	Numbers required	Two (2) (1 W+ 1 S)
3)	Duty	Intermittent
4)	Location	In regeneration shed
5)	Liquid to be Handled	48% NaOH
6)	Capacity & Head of each Pump (Minimum)	15 M^3/hr @ 15 mWC
7)	**Material of Construction**	
	1) Casing, Impeller, Wearing rings (as applicable)	SS-316
	2) Shaft, shaft sleeves	SS-410

C) Tanks / Vessels		Acid Measuring Tank	Alkali Preparation Tank	Alkali Day Tank
1)	Type	Vertical Cylindrical atmospheric		
2)	Numbers required	As specified	As specified	As specified
3)	Liquid to be handled	HCl	NaOH	NaOH

4)	Effective Capacity	As specified	As specified	As specified
5)	Material dissolving basket	Not applicable	SS-316	SS-316
6)	No of stirrer/agitator	Not applicable	Motor driven with reduction gear units	
7)	Shell material	--------- Mild Steel as per specified code --------		
8)	Shell (Internal) lining Material & Thickness	---------Rubber & minimum 4.5 mm ---------		
9)	External painting	---------Chlorinated Rubber Paint ---------		
D) Tanks / Vessels		**AC Filter for Alkali**	**Alkali Diluent Water Heating Tank**	
1)	Type	Vertical Cylindrical Pressure vessel with dished ends		
2)	Numbers required	One (1)	One (1)	
3)	Liquid to be handled	NaOH	Hot Water	
4)	Type of Heater	Not Applicable	Electric (2 x 50%)	
5)	Capacity	10 Cu.m/hr (Design flow rate)	As specified	
6)	Design surface flow	15 $M^3/hr/M^2$	Not applicable (NA)	
7)	Filter media	Activated carbon	NA	
8)	Minimum bed depth	1000 mm	NA	
9)	Supporting material for fill	Graded gravel	NA	
10)	Shell material	--------- Mild Steel as per specified code --------		
11)	Shell (Internal) lining/painting Material	Epoxy	Rubber & minimum 4.5 mm thickness	

12)	External painting	---------Chlorinated Rubber Paint ---------

15.00.00 **NEUTRALISING SYSTEM (DM PLANT)**

A) N-PIT

1)	Number	One (1) in two Sections
2)	Material of Construction	R.C.C with acid/alkali proof tiles
3)	Corrosion Protection for gates	Acid/Alkali proof chlorinated paint & rubber lined.
4)	Effective capacity	As specified

B) N-PIT WASTE RE-CIRCULATION CUM-DISPOSAL PUMPS

1)	Type of Pumps	Horizontal centrifugal with priming system
2)	Total Number of Pumps	Three (1W+1S +1 Maint.Spare)
3)	Duty	2-4 hrs every shift
4)	Liquid to be Handled	DM Plant Regeneration waste
5)	Pumps and drives to be designed	For Outdoor duty
6)	Suction condition	Suction from priming chamber/submerged (suction from pit)
7)	Guaranteed Flow of each pump	Capacity to evacuate total pit in 3 hours
8)	Total head	As reqd.
9)	Maximum pump Speed	1500 rpm
10)	Type of pump casing	Preferably Radially Split type
11)	Type of impeller	Closed / Semi Open
12)	**Material of Construction**	

	i) Casing	Rubber lined, Cast iron IS : 210 Grade FG 260
	ii) Impeller	Rubber lined, Cast iron IS : 210 Grade FG 260
	iii) Wearing rings (if applicable)	SS -316
	iv) Shaft/Shaft sleeves	SS -410

C) LIME TANKS FOR NEUTRALISATION

1)	Numbers. required	One (1)
2)	Type of construction	RCC
3)	Effective Capacity (Minimum)	2 CuM
4)	Inside protection	Epoxy
5)	Dissolving basket Material	SS -316.
6)	Agitator	SS-316

D) BACKWASH WASTE WATER COLLECTION & RECYCLING SYSTEM

D1	**Back Wash Waste water Collection Pit & Sump (DM)**	
1)	Number	One (Twin sections) with a common sump
2)	Material of construction	R.C.C. with Acid/Alkali proof lining
3)	Effective capacity each sections	Not less than 75 Cu.M
4)	Corrosion Protection for gates	Acid/Alkali proof chlorinated paint & rubber lined.

D2	**Back Wash Waste Water Recirculation cum disposal pump (Vertical Sump Pumps)**	
1)	Location	In Filter Backwash Sump
2)	Total Number of Pumps	Two (2)(2x100%)(1W+1S)
3)	Guaranteed Flow of each pump	Capacity to evacuate the pit in 2 hrs.
4)	Total head	As reqd.
5)	Type of pump	---Vertical, non-clog, Sump pumps --
6)	Type of Working Fluid	---Drains with particle size up to 40 mm
7)	Type of impeller	---------- Open ----------
8)	Suction Bell /Casing	ASTM A 351 CF8M, SS– 316
9)	Impeller , Shaft, Sleeves	ASTM A 351 CF8M, SS– 316
10)	Column pipe & Discharge Pipe	SS– 316
11)	Shaft enclosing tube (if applicable)	SS– 316

16.00.00 **DM WATER STORAGE TANKS**

1)	Type	Vertical Cylindrical atmospheric
2)	Design Standard	IS :803
3)	Numbers required	Three (3)
4)	Shell material	Mild Steel as per specified code
5)	Shell thickness (minimum)	Bottom most Course -10 mm Balance Courses – 8 mm
6)	Bottom Plate Thickness (minimum)	10 mm
7)	Roof Plate Thickness (minimum)	6 mm

8)	Internal Protection	Solvent free epoxy coating
9)	External painting	Epoxy Paint
10)	Manholes	Minimum 2 numbers (one on the shell and other on the roof)
11)	Accessories	a) Stair-case & platform b) Vent, Overflow and drain connections c) Overflow seal d) CO_2 absorbers in vent line e) Hand railing on the roof of the tank all around the tank
12)	Additional connections	Minimum Two (2) Numbers one of 250 NB size & another of 150 NB size at bottom level (for suction). Minimum Two(2) numbers one of 150 NB size & another of 100 NB size at the top level (for future filling)

17.00.00 **RO & MB PLANT**

A	**ULTRAFILTRATION UNIT**	
No	**Descriptions**	**Parameter /Data**
1)	Nos. of trains	2x50 %
2)	Feed Temperature	20-36 Deg. C
3)	Recovery from UF	Not less than 95%
4)	UF Treated (Filtrate) Flow	Capacity of each UF to match with gross capacity of RO + Water required for backwashing of UF membrane Chemical preparation requirements Plus 5% margin over the above total requirements. (Not less than 100 Cu.m/hr.)
5)	Mode of Operation	Dead End/Cross Flow
6)	Type of Operation	Automatic Back wash

7)	Type of membrane	Hollow Fiber
8)	Type of membrane mounting	Horizontal/Vertical
9)	Flux Rate	< 60 LMH
10)	MOC of membranes	PVDF/Polysulphone/Polyether Sulfone
11)	MOC of Membrane Housing	PVC
B	**BASKET STRAINER**	
1)	Number	Two(2) (1W+1S) for each stream/train
2)	MOC	SS-316
3)	Size	100 Microns
4)	Filtration Capacity	Strainer shall be sized for rated flow of UF filter water pump
C	**UF PERMEATE WATER STORAGE TANK**	
1)	Fluid to be Stored	Permeate Water produced from UF
2)	Type of Tanks	Vertical Cylindrical Atmospheric
3)	No of tanks	Two(2)
4)	Design Standard	IS : 803
5)	Size of Tank	6.0 m Dia. X4.5 m Ht.
6)	Material of construction	MS as per specified code
7)	Shell thickness	Bottom most layer : 10 mm (min.) Balance layer : 8 mm (min.)
8)	Bottom plate thickness	10 mm (minimum)
9)	Inside protection	Solvent free epoxy coating
10)	External painting	Epoxy coating.
11)	Manholes	Ref. DM tank above
12)	Accessories	Ref. DM tank above

13)	Additional nozzle connections	Ref. DM tank above

D. UF PERMEATE TRANSFER PUMPS		
No	**Description**	**Parameters/ Data**
1)	Purpose	To pump UF permeate to RO units via cartridge filters
2)	Type of pumps	Horizontal Centrifugal (With VFD)
3)	Number of Pumps(Working+ Standby)	Three (3) (2W+1S)
4)	Design flow (Cum/hr)	To suit the gross capacity of RO system requirements
5)	Rated Head of pump in MWC	As required
6)	**Material of Construction**	
	a) Casing	2.0 % Ni CI IS 210 Gr FG 260
	b) Impeller	ASTM A CF 8M
	c)Wearing rings (if applicable)	SS -316
	d)Shaft	SS -420 /SS-316
	e)Shaft sleeves	SS – 420 /SS-316

E. UF FILTRATE CUM BACKWASH WATER PUMPS		
No	**Description**	**Parameters/ Data**
1)	Purpose	Backwashing and CEB of UF skids
2)	Type of pumps	Horizontal Centrifugal with VFD
3)	Number of Pumps	Two (2) (1 W+1 S)
4)	Design flow & head	As required

E. UF FILTRATE CUM BACKWASH WATER PUMPS		
No	**Description**	**Parameters/ Data**
5)	**Material of Construction**	
	a) Casing	2.5 % Ni CI IS 210 Gr FG 260
	b) Impeller	ASTM A CF 8M
	c) Wearing rings (if applicable)	SS -316
	d) Shaft	SS -420 /SS 316
	e) Shaft sleeves	SS – 420 /SS 316

17.01.00 **CARTRIDGE FILTERS & RO TRAINS/STREAMS**

A.	**CARTRIDGE FILTERS**	
1)	Filtration Capacity of each filter	Capacity one CF same as capacity of one (1) UF
2)	Numbers	One (1) for each RO stream with a common standby.
3)	Type of filtration unit	Horizontal/Vertical type, as per layout
4)	Filtration Efficiency	95% down to 1 microns
5)	MOC of Filter Element	Polypropylene
6)	Filter Casing & Internals	SS -316
B.	**RO TRAINS /STREAMS**	
1)	Number of trains	3x50% (2W+1S)
2)	Turn Down Capability	One or both the trains shall be operable as per requirement
3)	Design net capacity of each train (Permeate Flow)	Not less than 80 Cu.m/h
4)	Gross capacity of each train	Not less than 80 Cu.m/h +Internal consumption of RO system

5)	Number of Membrane (Block) per Train	One or more as per design
6)	No of Membranes per module	6 - 8
7)	Guaranteed Design Recovery	Not less than 85%
8)	Membrane type	Polyamide, Spiral wound
9)	Average Flux	<20 L/M^{2}h
10)	Fouling Allowance for design	Minimum 5% per year
11)	Salt passage increase	Minimum 10% per year
12)	End connectors	Victaulic coupling or equiv.(SS-316)
C.	**HIGH PRESSURE FEED PUMP**	
1)	Purpose	To pump filtered water at the downstream of Cartridge filters up to the Degasser towers through RO trains.
2)	Number of pumps	One(1) per RO train with a common standby
3)	Type of Pumps	Centrifugal with VFD
4)	Design flow rate of each Pump	To suit the Gross capacity of each RO train
5)	Rated Head	1.10 x (RO train Feed Pressure + frictional loss in the system)
6)	Service Duty	Continuous
7)	Type of pump casing	As per manufacturer's standard
8)	Type of impeller	Closed / Semi-open
9)	**Material of Construction (Casing, Impeller, Shaft)**	ASTM A351, CF8M/SS 316
D.	**RO PERMEATE WATER STORAGE TANKS**	
1)	Number required	Two (2)

2)	Capacity of each tank	6m Dia.x4.5 m Ht.
3)	Type and Pr. class	Vertical cylindrical atmospheric.
4)	Design Standard	As per IS: 803
5)	Material of construction	MS as per specified code
6)	Shell thickness Bottom plate thickness	Bottom most layer : 10 mm (min.), Balance layer : 8 mm (min.) : 10 mm (min.)
7)	Inside protection	Solvent free epoxy coating.
8)	External painting	Epoxy coating.
9)	Manholes	Ref DM tank above
10)	Accessories	Ref DM tank above
11)	Additional nozzle connections	Ref DM tank above
E.	**CHEMICAL CLEANING SYSTEM**	
1.	**CHEMICAL TANKS**	
1)	Numbers Required	One (1)
2)	Effective Capacity	Total Piping + Volume of one RO Train
3)	**Material of Construction**	FRP or Mild steel with 4.5 mm thick rubber lined
4)	Accessories	One (1) mixer per tank; Motor driven with reduction gear unit. Chemical Filling, Overflow & drain Connections with valves
2.	**CHEMICAL CLEANING PUMPS**	
1)	Numbers Required	Two (2) (2x100%) (1W+1S)
2)	Type	Horizontal Centrifugal
3)	Design flow rate of each Pump	Suitable for cleaning of one (1) RO

		train/stream at a time.
4)	Rated Head of pump	As required.
5)	**Material of Construction** Wetted parts	SS-316/As per proven practice of RO plant supplier
3.	**CARTRIDGE FILTERS** (For Chemical cleaning)	
1)	Numbers Required	One(1)
2)	Capacity of each filter	To suit chemical cleaning pump capacity
3)	Filtering Efficiency	90% down to 3 microns
4)	Filter Element	Polypropylene wound filament
5)	MOC of Filter Casing	SS-316/As per proven practice of RO plant supplier.
F.	**FLUSHING SYSTEM**	
1)	Flushing Pumps	
2)	Numbers Required	Two (2) (2x100%) (1 W + 1 S)
3)	Type	Horizontal Centrifugal
4)	Design flow rate of each Pump	Suitable for cleaning of one RO train/stream at a time
5)	Rated Head of pump	As Required
G.	**DEGASSER SYSTEM**	
1)	Degassed Tower, Degasser blower & pumps	Ref. for DM plant

17.02.00 **MIXED BED (MB) POLISHER UNITS (RO PLANT)**

1)	Type	Vertical shell type with dished ends

2)	Number of units	Three (3) (2W+1S)
3)	Design flow per unit (net)	Not less than 80 M^3/hr
4)	Gross flow rate per MB unit	To be decided by bidder considering DM water required for regeneration.
5)	Service Cycle (period between two (2) successive regenerations)	24 hrs.
6)	Design surface flow rate at design flow	Not more than 35 M^3/M^2/hr
7)	Shell & dished end material	Mild steel as per specified code
8)	Shell lining	
	a)Material	Rubber
	b)Thickness	4.5 mm (minimum)
9)	External painting	Chlorinated rubber paint
10)	Manhole	Two (2) per vessel (Min.)
11)	Sight windows	Two (2) minimum per vessel (Minimum clear width shall be 75 mm)
12)	**Resins**	
	a)Type	Strongly acidic and strongly basic Type-I, both the resin shall be of high capacity polystyrene resins in bead form.
	b)Regeneration	By HCl and NaOH
	c)Total resin bed depth	1.0 M (min)
13)	**Air-blowers for Mixed Beds**	
	Number	Two (2x100%)
	Type	Centrifugal/Twin lobe type
	Capacity & Head	As required

18.00.00 **DATA SHEET FOR DOSING SYSTEM FOR UF AND RO**

A.	**SMBS & ANTISCALANT DOSING SYSTEM**		
1)		**SMBS DOSING TANK**	**ANTI SCALANT DOSING TANK**
	No of tanks	2 W	2W
	Capacity	500 Lit (Min)	500 Lit (Min)
	Material of Construction	MSRL / FRP	MSRL / FRP
	Tank Mixer/Agitator	Turbine Agitator	Turbine Agitator
	Material of Construction Mixer/Agitator	SS-316	SS-316
2)		**SMBS DOSING PUMPS**	**ANTISCALANT DOSING PUMPS**
	No.	2(1W+1S)	2(1W+1S)
	Type	Positive displacement	Positive displacement
	MOC	PP	PP

B. DOSING SYTEM

1.	**COAGULANT UNLOADING CUM TRANSFER PUMPS**	
1)	Purpose	To pump Coagulant from Tankers to Bulk Coagulant Storage Tanks and as well as to transfer Coagulant from Bulk Coagulant Storage Tanks to Coagulant Preparation tanks
2)	Chemical to be used	Ferric Chloride of 35 – 45 % concentration
3)	Type	Horizontal Centrifugal

4)	Numbers required	As specified	
5)	**Material of Construction** Casing, Impeller	FRP/ PP / CPVC	
6)	Sets of Hoses with coupling & Diaphragm type Isolation Valves		
	i) Number of Sets Required	Two (2)	
	ii) Size of hose/ Valve	80 mm NB	
	iii) Length of hoses	20 m (min.)	
	iv) Material of hose	Chemical resistant, UV inhibited PVC	
2.	**BULK COAGULANT STORAGE & PREPARATION TANKS**		
	DESCRIPTION	**BULK TANKS**	**PREPARATION TANKS**
1)	Purpose	To store one(1) month requirement of Coagulant	To prepare & store one(1) day requirement of Coagulant
2)	Chemical to handled	Ferric Chloride of 35–45% concentration	Ferric Chloride of 10 % concentration
3)	Number of tanks	As specified	As specified
4)	Design Dosage rate	---------As required------	
5)	Design Quantity of Water to be dosed	Total flow of one DM Clarifier	
6)	Capacity of each tank	To store 15 days requirement (minimum 15 cum)	To hold 12 hours requirement
7)	Type of Tank	Vertical (As per IS-803) or Horizontal atmospheric vessel (As per BS-2594) ;	Vertical, atmospheric; Covered

		Covered	
8)	Material of Construction	MSRL	MSRL/ FRP
	a. Number of agitators	NA	One per tank
	b. Shaft, Impeller Material of Agitator	NA	SS 316 L / MS with FRP lining
3.	**COAGULANT DOSING PUMPS**		
1)	Purpose	For dozing coagulant solution in PT system	
2)	Chemical to dosed	Ferric Chloride 10 % concentration	
3)	Type	Simplex hydraulically operated Diaphragm type	
4)	Numbers required	As specified	
5)	Design flow rate	To suit minimum dosage rate of 15 ppm	
6)	Rated Head of pump	As required	
7)	Capacity control	0 --100% of capacity by micrometer dial	
8)	Pump stroke speed per minute	100 maximum	
9)	**Material of construction**		
	a) Liquid end (pump head valve, valve housing)	PP / FRP/CPVC/Rubber lined steel	
	b) Diaphragm	Teflon	
4.	**BULK COAGULANT AID STORAGE & PREPARATION TANKS**		
	DESCRIPTION	**BULK STORAGE**	**PREPARATION TANKS**
1)	Design Storage Capacity to be considered	To store one(1) month requirement of Coagulant-aid	To prepare & store one 12 hrs. requirement of Coagulant –aid solution

2)	Chemical to handled	Polyelectrolyte - As recommended by RO plant - 100% Solution	Polyelectrolyte - As recommended by RO plant –0.5% solution
3)	Method of storage/ Preparation	To be stored in the form of 50 Kg Carboys	In Tanks
4)	Number of tanks	Not Applicable	Two (2)
5)	Design Dosage rate	------- Minimum 2 ppm ---------	
6)	Design Quantity	Total flow of DM Clarifier	
7)	Type of Tank	Vertical, atmospheric; Covered	
8)	Material of Construction	MSRL/FRP	
	a. Agitator & Number	One(1) per tank	
9)	b. Agitator shaft, impeller Material	SS 316 L / MS with FRP lining	
5.	**COAGULANT AID DOSING PUMPS**		
1)	Purpose	For dosing Coagulant aid solution in PT System	
2)	Chemical to dosed	Polyelectrolyte solution of 0.5 % concentration	
3)	Type	Simplex hydraulically operated Diaphragm type	
4)	Numbers required	As specified	
5)	Design flow rate	Total flow of DM clarifier	
6)	Capacity control	0 --100% of capacity by micrometer dial	
7)	Pump stroke speed per minute	100 maximum	
8)	MOC		

	a) Liquid end (pump head valve, valve housing etc.)	PP / FRP/ CPVC	
	b) Diaphragm	TEFLON	
	c) Shaft	As per manufacturer's Standard suiting to Chemical	
	d) Accessories	Check valves, Pressure Dampeners, Safety Relief valves etc. as required	
6.	**BULK ANTI-SCALANT STORAGE & PREPARATION TANKS**		
1)	**DESCRIPTION**	**BULK STORAGE**	**PREPARATION TANKS**
2)	Design Storage Capacity to be considered	To store one(1) month requirement of Anti-scalant	To prepare & store 12 hrs. requirement of Anti-Scalant solution
3)	Chemical to handled	As required	As required
4)	Method of storage / Preparation	As applicable	In Tanks
5)	Number of tanks	NA	As specified
6)	Design Dosage rate	------- Minimum 5 ppm ---------	
7)	Type of Tank	Vertical, atmospheric; Covered	
8)	MOC	MSRL/ FRP	
9)	Agitator & Number	One per tank	
10)	Agitator shaft, impeller Material	SS 316 L / MS with FRP lining	
7.	**ANTI-SCALANT DOSING PUMPS**		
1)	Purpose	For dosing Anti-Scalant solution in RO feed	
2)	Chemical to dosed	Anti-scalant solution of 5 % concentration	
3)	Type	Simplex hydraulically operated Diaphragm type	

4)	Numbers required	As specified	
5)	Duty	Continuous	
6)	Design flow rate of each dosing pump	To suit minimum dosage rate of 5 ppm	
7)	Rated Head of pump	As required	
8)	Capacity control	0 --100% of capacity by micrometer dial	
9)	Pump stroke speed per minute	100 maximum	
10)	**Material of Construction**		
	Liquid end (pump head valve, valve housing etc.)	PP / FRP /CPVC	
	Diaphragm	TEFLON	
8.	**BULK ANTI-OXIDANT STORAGE & PREPARATION TANKS**		
	DESCRIPTION	**BULK STORAGE**	**PREPARATION TANKS**
1)	Design Storage Capacity to be considered	To store one(1) month requirement of Anti-Oxidant	To prepare & store 12 hrs requirement of Anti-Oxidant solution
2)	Chemical to handled	Sodium Meta bisulphite (SMBS)– 40-45% Solution	Sodium Meta bisulphite (SMBS) - 5% Solution
3)	Method of storage / Preparation	To be stored in the form of 50 Kg Carboys	In Tanks
4)	Number of tanks	As required	Two (2)
5)	Design Dosage rate	To suit removal of chlorine (Minimum 5 ppm)	
6)	Type of Tank	Vertical, atmospheric; Covered	
	MOC	MSRL/ FRP	

	a. Agitator & Number	One per tank
	b. Agitator shaft, impeller Material	SS 316 L / MS with FRP lining
9.	**ANTI-OXIDANT DOSING PUMPS**	
1)	Purpose	For dosing Anti-oxidant solution in RO feed
2)	Chemical to dosed	Anti oxidant solution of 10 % concentration
3)	Type	Simplex hydraulically operated Diaphragm type
4)	Numbers required	As specified
5)	Duty	Continuous
6)	Design Quantity	Total flow of two RO Plant Feed HP Pumps
7)	Design flow rate of each dosing pump	To suit minimum dosage rate of 5 ppm
8)	Rated Head of pump	As required
9)	Capacity control	0 --100% of capacity by micrometer dial
10)	Pump stroke speed per minute	100 maximum
11)	MOC	
	a) Liquid end (pump head valve, valve housing etc)	PP / FRP /CPVC
	b) Diaphragm	Teflon
10.	**ACID UNLOADING CUM TRANSFER PUMPS**	
1)	Purpose	To pump Acid from Tankers to Bulk Acid Storage Tanks and as well as to transfer Acid from Bulk Acid Storage Tanks to Measuring tanks
2)	Chemical to be used	Hydrochloric Acid – 30- 33% Concentration
3)	Type	Horizontal Centrifugal

4)	Numbers required	As specified	
5)	Duty	Intermittent	
6)	**Material of construction**		
	a. Casing, Impeller	PP	
	b. Wearing Rings	As per manufacturer's standard	
	c. Shaft, Shaft Sleeve	PP / EN-8	
7)	Sets of Hoses with coupling & Diaphragm type Isolation Valves		
	i)Number of Sets Required	Two (2)	
	ii) Size of hose/ Valve	80 mm NB	
	iii) Length of hoses	30 meters (minimum) Chemical resistant, UV inhibited PVC	
11.	**BULK ACID STORAGE & PREPARATION TANKS**		
1)	**DESCRIPTION**	**BULK TANKS**	**MEASURING TANKS RO & MB**
2)	Chemical to be handled	.Hydrochloric Acid of 30–33% concentration/RO (HCL-5% conc.)..	
3)	Capacity of each tank	To store one(1) month requirement of Acid reqd. for MB & RO requirements (minimum 15 cum)	i) To prepare & store acid for 12 hrs requirement for pH control ii) To prepare and store for one(1) MB regeneration
4)	Number of tanks	Two(2)	One (1) One(1)
5)	Design Dosage rate (Dosage rate indicated are minimum)	Total volume to be sized for dosing of 25 ppm in PT Plant of RO (at the upstream of and	i) Total volume to be sized for dosing of 25 ppm in PT Plant of RO (at the upstream

		Cartridge filters) plus dosage rate for regeneration of MB Ion Exchanger	of and Cartridge filters) ii) As per regeneration level employed for MB unit
6)	Type of Tank	Horizontal / vertical atmospheric vessel	Vertical, atmospheric; Covered
7)	MOC of tank	MSRL	MSRL/ FRP
12.	**ACID DOZING PUMPS FOR RO AND MB**		
1)	Purpose	i) For dosing acid solution at upstream of cartridge filters-RO plant ii) For regeneration of cation resins of MB exchanger	
2)	Chemical to dosed	Hydrochloric Acid of about 5% concentration	
3)	Type	Simplex hydraulically operated Diaphragm type	
4)	Numbers required	i) Two (2) (1W+1S) for RO ii) Two (2) (1W+1S) for MB	
5)	Duty	Continuous/Intermittent	
6)	Capacity control	--0 -100% of capacity by micrometer dial -	
7)	Pump stroke speed per minute	---------- 100 maximum ----------	
8)	**Material of Construction**		
	a. Liquid end (pump head valve, valve housing, etc) ,valve spring	---------- PVC ----------	
	b. Diaphragm	---------- TEFLON ----------	
	c. Shaft	Hardened steel EN8-BS-970 / As per manufacturer's Standard suiting to Chemical	

13.	**ALKALI UNLOADING PUMPS & ALKALI TRANSFER CUM RECIRCULATION PUMPS**		
1)	**DESCRIPTION**	**UNLOADING PUMPS**	**TRANSFER CUM RECIRCULATION PUMPS**
2)	Purpose	To pump Alkali from Tankers to Bulk Alkali Storage Tanks.	a)To pump Alkali from Bulk Alkali Storage Tanks and preparation tanks. b) To pump alkali prepared using flakes from alkali preparation tanks to Bulk alkali storage tanks
3)	Chemical to be used	----------Sodium Hydroxide (48% Conc) -----	
4)	Type	----------Horizontal Centrifugal ----------	
5)	Numbers required	As specified	As specified
6)	Duty	Intermittent	
7)	Design flow rate of each pump	15 Cu.M/hr (min.)	10 Cum/hr (min.)
8)	Rated Head of pump	As required	As required
9)	Maximum Pump Speed	----------1500 rpm ----------	
10)	**Material of Construction**		
	a) Casing, Impeller, wearing rings	---------- SS-316 ----------	
	b) Shaft, shaft sleeve	SS-410	
11)	Sets of Hoses with coupling & Diaphragm type Isolation Valves		
12)	Number of Sets Required	Two (2)	nil

13)	Size of hose/ Valve	80 mm NB	nil
14)	Length of hoses	30 meters (minimum) Chemical resistant, UV inhibited PVC	nil
14.	**BULK ALKALI STORAGE TANKS & PREPARATION TANKS**		
1)	**DESCRIPTION**	**BULK ALKALI TANKS**	**ALKALI PREPARATION TANKS**
2)	Capacity of each tank	To store one(1) month requirement of Alkali (minimum 15 cum)	To Prepare alkali from flakes
3)	Chemical to handled	Sodium Hydroxide of 48% concentration	
4)	Number of tanks	As specified	As specified
5)	Capacity of Tank	To be designed for design dosage rate & design flow for one(1) month (minimum)	2 Cum (minimum)
6)	Design Dosage rate (Dosage rate indicated are minimum)	For dosing in permeate of RO for pH control (minimum 5 ppm) Dosage rate for regeneration of MB	-------
7)	Design Quantity of Water to be dosed with acid for estimation of storage volume	a. For permeate pH control, gross capacity of all the streams of RO to be considered b. For MB regeneration alkali required as per process calculation to be considered	

8)	Type of Tank	Horizontal atmospheric vessel	Vertical, atmospheric; Covered
9)	**Material of Construction**	MSRL	MSRL
10)	Number of agitators	NA	One (1)
11)	Shaft, impeller Material of Agitator	NA	SS-316
12)	Accessories	Manholes/Hand holes, Filling Connection, Vent, overflow, drains, CO_2 absorbers, valves operating platform, ladders etc. as applicable	
15.	**ALKALI MEASURING TANKS**		
1)	Chemical to handled	Sodium Hydroxide of 5% concentration	
2)	Number of tanks	Two (2) (1) each for MB exchanger & RO plant as applicable)	
3)	Design Dosage rate (Dosage rate indicated are minimum)	Total volume to be sized for i) As per regeneration level employed in MB unit ii) Dosing of 5 ppm in permeate of RO for pH Control	
4)	Design Quantity of Water to be dosed with acid for estimation of storage volume	i) For MB, alkali reqd. as per process calculations ii) For permeate pH control, capacity of all the trains of RO to be considered	
5)	Capacity of each tank	To hold 12 hours requirement	
6)	Type of Tank	Vertical, atmospheric; Covered	
7)	**Material of Construction**	MSRL/ FRP	
	i. Number of agitators	One (1) in each tank	

	ii. Shaft, impeller Material of Agitator	SS-316
16.	**ALKALI DOSING PUMPS**	
1)	Pump Designation	i) Alkali Dosing Pumps – RO ii) Alkali Dosing Pumps – MB
2)	Purpose	For dosing Alkali solution in permeate of RO plant & MB exchanger
3)	Chemical to dosed	Sodium Hydroxide solution of about 5% concentration
4)	Type	Simplex hydraulically operated Diaphragm type
5)	Numbers required	i) Two (2)(1 W+ 1 S) for RO ii) Two (2)(1 W+ 1 S) for MB
6)	Duty	Continuous
7)	Design Quantity of Water to be dosed	i) Total permeate flow of all RO trains/streams ii) As per regeneration level employed in MB unit
8)	Design flow rate of each dosing pump	As reqd.
9)	Capacity control	--- 0 --100% of capacity by micrometer dial -
10)	Pump stroke speed per minute	---------- 100 maximum ----------
11)	**Material of Construction**	
	a) Liquid end (pump head,valve, valve housing, etc) ,valve spring	---------- SS-316 ----------
	b) Diaphragm	---------- TEFLON ----------
	c) Shaft	Hardened steel EN8-BS-970 / As per manufacturer's Standard suiting to chemical dosed

17	ACTIVATED CARBON FILTER FOR ALKALI (RO Plant)	
No	**Description**	**AC Filter**
	Purpose	To filter impurities from alkali.
1)	Chemical to handled	NaOH
2)	Number	One (1)
3)	Capacity of filter	10 Cum/hr
4)	Design surface flow rate	12 Cum/hr/Sqm
5)	Type of Vessel	Vertical Cylindrical Pressure vessel with dished ends
6)	Filter media	Activated Carbon
7)	Minimum bed depth of AC media	1000 mm
8)	Free Board over media depth	75%
9)	Material of Construction	MSRL
10)	Accessories	Manholes/hand holes, Vent, overflow, drains, valves operating platform, ladders etc. as applicable

19.00.00 **WASTE WATER RO**

19.01.00 **WASTE WATER RO**

A	As specified	As specified
a)	Clarifier	1x150 m3/hr
b)	Gravity sand filter	2x75 m3/hr
B	**AUTO BASKET STRAINER**	
1)	Quantity	2

2)	Type	Basket strainer, with auto cleaning
3)	Design flow per strainer	To match the capacity of UF
4)	**Material of Construction**	
	Casing , Perforated Sheets	SS-316

B	**ULTRAFILTRATION (UF) SKID**	
No	Description	Parameters/ Data
1)	Nos. of UF skid/Stream	2 x 50 %
2)	Recovery from UF	95%
3)	UF Permeate (Filtrate) Flow	Capacity of each UF to match with gross capacity of RO+water required for backwashing of UF membrane + chemical preparation requirements. With 5% margin over the above total requirements.
4)	Type of Operation	Automatic Back wash
5)	Type of membrane	Hollow Fiber
6)	Flux Rate for ETP water	Less than 60 LMH
7)	MOC of membranes	PVDF/Polysulphone/Polyether Sulfone
C. UF PERMEATE WATER STORAGE TANK		
	Description	Parameters/ Data
1)	Fluid to be Stored	Permeate Water produced from UF
2)	Type of Tanks	Vertical Cylindrical Atmospheric
3)	Design Standard	IS:803
4)	Size of Tank	Retention time 60 mins (min.)
5)	Numbers required	One (1)

D. UF PERMEATE TRANSFER PUMPS AND UF BACKWASH WATER PUMPS			
Description		**UF Permeate Transfer Pumps**	**UF Filtrate cum backwash water Pumps**
1)	Purpose	To pump UF permeate to RO units via cartridge filters	To pump UF permeate to UF storage tank and backwashing of UF
2)	Type of pumps	Horizontal Centrifugal with VFD	Horizontal Centrifugal with VFD
3)	Number of Pumps	Three (3) (3x50%)	Two (2) (2x100%)
4)	Design flow (Cum/hr)	To suit the gross capacity of RO system requirements	As required
5)	Rated Head of pump in MWC	As required	
6)	Type of pump casing	As per manufacturer's standard	
7)	Type of impeller	Closed / Semi-open	
8)	**Material of Construction**		
	a) Casing	2.5 % Ni CI IS 210 Gr FG 260	
	b) Impeller, wearing rings	ASTM A CF 8M,SS-316	
	c) Shaft	SS-420 /SS 316	
	d) Shaft sleeves	SS-420 /SS 316	
E.	**Cartridge Filters**		
1)	Fluid Handled	Permeate of UF system	
2)	Type of Filtration unit	Horizontal / Vertical type , as per layout	
3)	Numbers	Three (3) (2 W+ 1 S)	

4)	Filtration Capacity of each Filter	Capacity of one Cartridge filter same as capacity of one UF
5)	Filtration Efficiency	95% down to 1 microns
	Material of Construction	
1)	Filter Element	Polypropylene
2)	Filter Casing & Internals	SS -316
F.	**High pressure feed pumps for Waste water RO**	
1)	Purpose	To pump filtered water at the downstream of Cartridge filters up to the Degasser towers through RO trains.
2)	Number of pumps	One(1) per RO train with a store standby
3)	Type of Pumps	Horizontal Centrifugal with VFD
4)	Design flow rate of each Pump	To suit the Gross capacity of each RO train
5)	Rated Head	1.10 x (RO train Feed Pressure + frictional loss in the system)
6)	Service Duty	Continuous
7)	Type of pump casing	As per manufacturer's standard
8)	Type of impeller	Closed / Semi-open
9)	**Material of Construction**	
	a) Casing	ASTM A351, CF8M
	b) Impeller	ASTM A351, CF8M
	c) Shaft	SS-316
G.	**RO Waste water Permeate Water Storage Tank**	
1)	Number required	One (1)
2)	Capacity	50 Cum.

3)	Type and Pr. class	Vertical cylindrical atmospheric.
4)	Design Standard	As per IS: 803
5)	**Material of construction**	MS as per specified code
6)	Shell thickness	Bottom most layer : 10 mm (min.), Balance layer : 8 mm (min.)
7)	Inside protection	Solvent free epoxy coating.
8)	External painting	Chlorinated rubber paint
9)	Man hole, additional nozzles	Ref.DM tank
10)	Accessories	Ref. DM tank
H.	**RO Trains /Streams**	
1)	Number of trains	Two (2 x 50%)
2)	Design Net Capacity of each Train (Permeate flow)	25 Cu.m/hr (minimum)
I.	**Membrane Assembly Unit(Block)**	
1)	Number of Membrane (Block) per Train	One or more as per design
2)	Number of Membranes per module	6 - 8
3)	Guaranteed Design Recovery	Not less than 90%
	Module	
1)	Internal Diameter	As per manufacturer Std
2)	Length	As per manufacturer to suit the element
	Elements	
1)	Membrane type	Polyamide, Spiral wound
2)	Diameter	As per manufacturer std.
3)	Length	As per manufacturer std.

4)	Average Flux	<20 L/M2h
5)	Fouling Allowance for design	Minimum 5% per year
6)	Salt passage increase	Minimum 10% per year

Note: Necessary Hardness & Silica removal system(s) if required, suitable for Waste Water RO plant shall be provided to meet the system requirements.

20.00.00 THICKENER

1)	Number of units	One (1)
2)	Capacity (each)	As required
3)	Scraper rake etc.	As per manufacturer's standard.
4)	Torque switch for alarm and for tripping	As per manufacturer's standard
5)	Side water depth	3.5 m (Minimum)

21.00.00 CENTRIFUGE/BELT FILTER PRESS

A	**CENTRIFUGE/FILTER PRESS**	
1)	No. of units	2X50%
2)	Type	Variable differential speed control type.
3)	Capacity	As required
4)	Screening at inlet	Required
5)	a) Centrate b) Drive	To be discharged at thickener inlet Hydraulic coupling to dampen the initial acceleration.
6)	Type	Variable differential speed control type.

B. SCREW PUMPS		
1)	Type	Single Screw Horizontal
2)	Qty.	2x50%
3)	Capacity	As per design
4)	Head	As required
5)	Type of Duty	Continuous
6)	Fluid to be pumped	7 to 10% thickened sludge
7)	**Material of Construction**	
	a) Casing	IS :210 FG 260
	b) Rotor, Stator , Shaft, Other rotating Parts	SS : 316
C.Coagulant/Polyelectrolyte Preparation Tank		
1)	Number	One(1)
2)	**Material of Construction**	MSRL
3)	Capacity	12 hour requirement of thickeners and centrifuge/filter press whichever is more.
4)	Agitator: Type	Motor driver with reduction gear unit
5)	MOC (Impeller & Shaft)	SS-316
D. Coagulant/Polyelectrolyte Dosing Pumps		
1)	Number	2 (2x100%)
2)	Type	Simplex hydraulically operated Diaphram type
3)	Capacity	Each sufficient to dose chemical in clarifiers, thickeners & centrifuges

4)	Head	As required
5)	Liquid to be handled and concentration	Coagulant aid 0.5% W/V
6)	Capacity control	0-100% manually by micro meter dial Automatically through pH Controller for acid dosing pumps.
7)	Maximum pump stoker speed for minute	100
8)	**Material of Construction**	
	a) Liquid end (pump) head valve, valve housing etc. valve spring)	AISI 316
	b) Diaphragm, packing	PTFE
	c) Shaft	EN8

20.00.00 **GENERAL DESIGN CRITERIA FOR WATER TREATMENT PLANT**

a) The chemical storage facilities shall be able to hold one (1) month requirements, chemical dosing tanks shall be able to hold one (1) day requirement (at least two (2) tanks in total or specified elsewhere), chemical dosage rate shall be as per the process requirement however, minimum chemical dosage rate shall be maintained as specified elsewhere.

b) All materials and components of valves, pumps, piping and other equipment and appurtenances shall be compatible with the respective fluid herein.

c) All the pumps shall have isolation valve at suction and electrically actuated isolation valve at discharge along with NRV. Further, recirculation line to be provided along with valves for all pumping systems.

d) General Design and Construction features of various Horizontal pumps, Vertical Pumps and Submersible pumps shall be generally conforming to the requirements specified in the Chapter titled ‘ACW System' unless otherwise mentioned.

e) All the pump sumps shall be provided with re-circulation system from the pump discharge and agitation arrangement by with the pumped fluid (perforated pipes/ network of recirculation pipes as the case may be) so that the effluents are properly mixed. Sumps handling sludge/thick slurry etc. (other than clear fluid) shall be provided with agitation system with (2x100% capacity) blowers.

f) Sumps/tanks shall generally consist of two (2) sections with a common sump interconnected with valves.

g) Vertical wet pit type pumps handling waste service water and decanted water shall be provided with forced water lubrication using a set of lubrication water pumps and an overhead tank filled from plant service water system.

h) Facilities for maintenance of the pumps by means of mobile cranes or jib crane or gantry cranes shall be provided based on pumps layout and as specified in Chapter titled 'Layout Requirements'. Hoist, mobile cranes shall be generally conforming to the requirements specified in Chapter titled 'Layout Requirements'.

i) Storage tanks shall be provided with vent, overflow, drain connections with required valves. Stair case, operating platform etc. shall be provided. Agitators shall be of SS-316 construction with motor driven reduction gear units.

j) Fasteners like bolts, nuts etc. shall be stainless steel for those coming in contact with water and for others high tensile carbon steel.

k) Base plate, sole plates for pumps, blowers etc. shall be carbon steel with epoxy coated.

l) Suitable permanent flushing connections shall be provided for all pipelines carrying sludge, acid and alkali.

m) The pipelines which are immersed inside the drain trench or in Neutralization pits shall be rubber lined to a height of at least 600 mm from the maximum liquid level apart from internal rubber lining.

n) All valves used with vessels shall be suitably arranged in the front in accessible position, for manual operation in case of emergency.

o) The valves under automatic operation of DM Plant shall be operated pneumatically by diaphragm actuator. Valves shall be spring to close or spring to open or double acting type as may be required by process consideration. The valves on effluent outlet as well as regenerant inlet of filters and ion-exchangers shall be of spring to close (Air to open) type only. Limit switches shall be provided for all the valves under automatic operation.

p) The solenoid valve shall be housed in a separate enclosure and shall be located near the respective vessels. The valves shall be provided with all

accessories such as isolating cocks, air supply headers etc. and shall have facility for operation from rack itself. Name plate with tag number shall be provided for each and every valve.

q) Rotary type actuators for butterfly valves are also acceptable.

25.00.00 **GENERAL REQUIREMENTS OF PIPING & VALVES FOR WATER TREATMENT PLANT**

A. <u>Piping</u>

All the piping shall generally be conforming to the requirements specified in the Chapter titled "Low Pressure Piping" considering the following aspects as minimum requirement:

S.No	Service	Material of Construction
1.	Raw water & Clarified water	<u>Carbon Steel</u>: IS: 1239 Part-I (Heavy grade-Black), ASTM-A-53 Type-E Grade B / ASTM A 36 / IS: 3589 - Grade 410; / IS-2062 Gr.-B (for fabricated from plates) / Equivalent
2	Filtered Water	<u>Stainless Steel:</u> Stainless Steel ASTM A 312 Gr. 304 Sch. 40 /Equivalent Seamless for Sizes 50 and above and welded for sizes 65 mm NB and above.
3	Not used	
4	Brine from RO plant	GRP as per ASTM D3517/AWWA C950-88/AWWA M45.
6	Permeate from RO Plant/ Demineralised Water	<u>Stainless Steel:</u> Stainless steel to ASTM A312, Gr. 304 Sch.40s seamless for sizes 50mm and below and welded for sizes 65 mm NB and above.
8	Degasified Water (RO Plant) Decationised & De-anionsed water	<u>Rubber lined Carbon Steel:</u> IS:1239 Part-I (Heavy grade-Black), ASTM-A-53 Type-E Grade B / ASTM A 36 / IS:3589 - Grade 410;/ ASTM A-36/ASTM - 53 Type- E, Grade B/ Equivalent and Galvanized to IS: 4736 or Equivalent internally lined with 3 mm thick Rubber of shore hardness 65 ± 5°A) Note: The inside surface of pipes shall be completely de-beaded and made suitable for

S.No	Service	Material of Construction
		rubber lining .
10	Concentrated Hydrochloric Acid (5-30% Conc.)	1) PP lined Carbon Steel: IS:1239 Part-I (Heavy grade-Black), ASTM-A-53 Type-E Grade B / ASTM A 36 / IS:3589 - Grade 410;/ Equivalent and Galvanized to IS: 4736 or Equivalent internally lined with 3 mm thick Polypropylene) 2) CPVC as per ASTM F441 CPVC 4120
11	Dilute Hydrochloric Acid (Less than 5% Conc.)	1) Rubber lined Carbon Steel: IS:1239 Part-I (Heavy grade-Black), ASTM-A-53 Type-E Grade B / ASTM A 36 / IS:3589 - Grade 410;/ Equivalent internally lined with 3 mm thick Rubber of shore hardness 65 ± 5°A) 2) Chlorinated Polyvinyl chloride (CPVC) as per ASTM F441 CPVC 4120
12	Sulfuric Acid a) Strong (Conc.)	Alloy 20/Equivalent (Butt-welded fittings shall be used)
	b) Dilute (upto 10%)	Polypropylene lined steel/Equivalent
13	Alkali (Sodium Hydroxide) a) Strong (5% and above)	Stainless Steel SS-316L
	b) Dilute (below 5%)	Polypropylene lined steel/CPVC as per ASTM F441 CPVC 4120 Schedule 80
14	Coagulant (Alum) PAC Solution	Rubber lined Steel/CPVC Schedule 80 CPVC Schedule 80
15	Lime slurry/Solution/ Suspensions	CPVC as per ASTM F441 CPVC 4120 Sch. 80
16	Coagulant (Ferric Chloride) , Anti-oxidant and Anti -	CPVC as per ASTM F441 CPVC 4120 Sch.80 or Equivalent

S.No	Service	Material of Construction
	scalant	
17	Coagulant aid Solution	Rubber lined Steel (as refereed above)/CPVC as per ASTM F441 CPVC 4120, Schedule 80/equivalent.
18	Liquid and Gas Chlorine (Under Pressure)	Seamless Carbon Steel Schedule 80 (Heavy Duty)
19	Chlorinated Water	1) Rubber lined Steel (as referred above) or CPVC as per ASTM F441 CPVC 4120 Schedule 80/equivalent. 2) HDPE as per ASTM D3350 CL 34543C, FM Class 150/ IS:4984 or Equivalent for buried portion
20	Wet Chlorine gas (Under Vacuum)	1) Polypropylene pipe as per relevant standard 2) CPVC as per ASTM F441 CPVC 4120 Schedule 80/equivalent.
21	Sludge	1) GRP as per ASTM D3517/ AWWA C950-88/AWWA M45 2) HDPE as per ASTM D3350 CL 34543C, FM Class 150/ IS:4984 or Equivalent for buried portion
25	Chemical Waste from vessels and tanks	1) Rubber lined Steel (as referred above) 2) HDPE as per ASTM D3350 CL 34543C, FM Class 150/ IS: 4984 or Equivalent for buried portion.
26	Frontal Piping of UF Skids	SS 304
27	SBS/Anti-scalant /NaOCl Solution Line	CPVC as per ASTM F441 CPVC 4120 Schedule 80/equivalent.
28	Cleaning Solution Line	SS316 Sch. 40 /CPVC as per ASTM F441 CPVC 4120 Schedule 80/equivalent.

S.No	Service	Material of Construction
30	not used	
31	Brine(RO reject)	GRP as per ASTM D3517/AWWA C950-88 / AWWA M45.

B.<u>Valves:</u>

All the valves shall generally be conforming to the requirements specified in the Chapter titled "Low Pressure Piping" considering the following aspects as minimum requirement:

S.No	Service	Type of Valves / Material of Construction
1.	Not used	-
2.	Not used	-
3.	Not used	-
4.	Low pressure	CPVC as per ASTM F441 CPVC 4120 Sch. 80
5.	High pressure Feed water of RO plant (From discharge of HP Feed pumps of RO plant upto degasser inlet)	**5.1 – Type of Valves** <u>For Isolation</u> a) Gate or Sluice or Ball or Globe type for Sizes upto 50 mm NB b) Gate or Sluice or Ball or Butterfly type for Sizes 65 mm NB to 200 mm NB c) Butterfly type for Sizes 250 mm NB & above <u>For Regulation /Control</u> a) Globe type for Sizes upto 50 mm NB b) Globe or Butterfly type for Sizes 65 mm NB & above <u>For non-return / Check</u> Swing Check or Dual Plate type valve

S.No	Service	Type of Valves / Material of Construction
		5.2 – Material of Construction Valves <u>Sluice & Gate Valves</u> a) Stem, seat ring and wedge facing ring of shall be of stainless steel (SS 316) construction b) Body/Bonnet shall be Stainless steel of ASTM A 351 Gr. CF 8M/ ASTM A 182 S30451/Eqvt. c) All other internal parts shall be epoxy coated against corrosion by sea water <u>Butterfly Valves & Globe Valves</u> a) Body & Disc shall be Stainless steel of ASTM A 351 Gr. CF 8M/ ASTM A 182 S30451/Eqvt. b) Shaft shall be of Stainless steel to ASTM. A 276 Gr S41000 / ASTM A 473 S41000 /. ASTM A 351 Gr.CF 8M / Eqvt. c) Seat shall be ASTM A182 F317/ASTM A 276 S31700/ASTM A 890 J93370 or Equivalent d) Seals shall be Nitrile rubber, EPDM (Ethylene propylene rubber), Hypalon <u>Ball Valves</u> a) Body shall be of Stainless steel of ASTM A 351 Gr. CF 8M/ ASTM A 182 S30451 b) Ball shall be Stainless steel to ASTM. A 276 Gr S31600 / ASTM A 473 S31600/.Eqvt c) Stem shall be ASTM A276 Gr S41000/ASTM A473 S41000 /Eqvt. d) Seat Ring shall be PTFE /Equivalent. e) Seats shall be ASTM A182 F316 /ASTM A 276 S31600/ Equivalent <u>Check Valves</u> a) Body & Cover, Hinge Disk/Door shall be ASTM A 351 Gr. CF 8M/ ASTM A 182

S.No	Service	Type of Valves / Material of Construction
		S30451 b) Hinge Pin and Door/Disc Pin shall be of Stainless steel to ASTM. A 276 Gr S3160 / ASTM A 473 S31600/Equivalent. c) Bearing bushes, Disc facing ring and Body Seat rings shall be ASTM. A 276 Gr S30400 / ASTM A 473 S30400/Equivalent. d) Material of construction of spring in dual plate type valve shall be of INCONEL or better
6.	Degasified & Demineralised water in RO Plant	**6.1 – Type of Valves** <u>For Isolation</u> a) Butterfly or Saunder's Patented Diaphragm Valves upto 200 mm NB b) Butterfly type for Sizes 250 mm NB & above <u>For Regulation /Control</u> a) Globe type for Sizes upto 50 mm NB b) Globe or Butterfly type for Sizes 65 mm NB to 200 mm NB <u>For non-return / Check</u> a) Lift Check type/Swing Check /Dual Plate type for sizes upto 40 mm NB b) Swing Check or Dual Plate type valve for sizes 50 mm NB & above
		6.2 - Material of Construction Valves <u>Diaphragm Valves</u> a) Body shall be Cast Iron to IS: 210 Gr FG 260 OR Cast Steel to ASTM. A 216 GR. WCB/Equivalent. and Body shall be internally lined with Soft Natural rubber, Ebonite or Polypropylene b) Diaphragm shall be Reinforced rubber, Hypalon/approved equivalent. Stem, Compressor & Bush shall be of Stainless

S.No	Service	Type of Valves / Material of Construction
		steel Construction. Butterfly Valves a) Body shall be Cast Iron to ASTM A 48 Cl.40; BS: 1452 Gr.220 SG Iron - BS: 2789; Cast Iron to IS: 210 Gr FG 260/Equiv. OR Cast Steel - ASTM. A 216 GR. WCB; BS:1504 Eq.Gr/Equivalent OR Fabricated Steel as per ASTM A515 Gr.60/80 and Body shall be internally lined with natural rubber, Ebonite or Polypropylene b) Disc shall be Cast Iron IS: 210 Gr FG 260; ASTM A 48 Cl.40; BS: 1452, Gr.220, SG Iron - BS:2789 OR Cast Steel - ASTM A 216 Gr. WCB; BS:1504 Eq.Gr/Equivalent OR Fabricated Steel as per ASTM A515 Gr.60/80 and Disc shall be internally lined with PVDF, natural rubber or Polypropylene. Alternatively Disc of Stainless Steel-316 construction is also acceptable. c) Shaft shall be of Stainless steel to ASTM. A 296 Gr. CF8M/AISI 316/ AISI 420 /BS:970 Gr.316; BS: 970 Gr.420 S45. d) Seat rings shall be Nitrile rubber /Hypalon/Eqvt. Globe Valves a) Body & Disc shall be Cast iron Cast Iron to IS: 210 Gr FG 260 or Eqvt. and internally lined with natural rubber, Ebonite or Polypropylene. b) Stem shall be Stainless steel AISI 410/ 13% chrome steel c) Packing shall be PTFE d) Seat & Seat rings shall be Nitrile rubber or Hypalon e) Hand wheel shall be Cast Iron or Equivalent.

S.No	Service	Type of Valves / Material of Construction
		Check Valves a) Body & Cover, Hinge Disk/Door shall be Cast Iron to IS: 210 Gr FG 260/ BS:1452 Gr.220 or Eqvt and shall be lined with natural Rubber, PTFE or Viton or Stainless Steel – 316 b) Hinge Pin and Door/Disc Pin shall be of Cast steel ASTM A 216 Gr. WCB and shall be coated with PVDF, or suitable elastomer or Stainless Steel – 316 c) Disc facing ring and Body Seat rings shall be Stainless Steel d) Bearing bushes shall be SS – 316. e) Material of construction of spring in dual type valve shall be of INCONEL or better
7.	Decationised, De-anionsed & Demineralised Water	**7.1 -- Type of Valves** Same as specified under 6.1 above
		7.2 -- Material of Construction Same as specified under 6.2 above
8.	Acid (Hydrochloric) Service	**8.1 – Type of Valves** For Isolation Saunder's Patented Diaphragm Valves For non-return / Check Flap type/Swing Check type /Dual Plate type
		8.2 - Material of Construction Valves Diaphragm Valves a) Body shall be Cast Iron to IS: 210 Gr FG 260/ ASTM A 48 Cl.40; BS: 1452 Gr.220 OR Cast Steel to ASTM. A 216 GR. WCB and Body shall be internally lined with Soft Natural rubber, Ebonite or Polypropylene b) Diaphragm shall be shall be of reinforced TEFLON, EPDM/Black Butyl/approved equivalent

S.No	Service	Type of Valves / Material of Construction
		c) Stem, Compressor & Bush shall be Stainless steel Construction Check Valves a) Body & Cover, Hinge Disk/Door shall be Cast Iron to IS: 210 Gr FG 260/BS:1452 Gr.220 or Equivalent and internally lined with natural Rubber, PTFE or Viton or Hastalloy –B b) Hinge Pin and Door/Disc Pin shall be of steel with PVDF, or suitable elastomer c) Disc facing ring and Body Seat rings shall be SS-317 L or resilient materials such as natural rubber, PTFE or Viton d) Bearing bushes shall be PTFE or Equivalent e) Material of construction of spring in dual type valve shall be of INCONEL or better
9.	Alkali Services	**9.1 – Type of Valves** For Isolation Saunder's Patented Diaphragm Valves For non-return / Check Swing Check type /Dual Plate type
		9.2 - Material of Construction Valves Diaphragm Valves a) Body shall be Cast Iron to IS: 210 Gr FG 260/ ASTM A 48 Cl.40; BS: 1452 Gr.220 OR Cast Steel to ASTM. A 216 GR. WCB and Body shall be internally lined with Soft Natural rubber, Ebonite or Polypropylene b) Diaphragm shall be shall be of reinforced Neoprene/Hypalon/ /Equivalent c) Stem, Compressor & Bush shall be Stainless steel Construction d) Hand wheel shall be of Cast Iron Check Valves

S.No	Service	Type of Valves / Material of Construction
		The complete valve shall be of stainless steel construction (AISI-316L)
10.	Acid (Sulphuric) Service	**10.1 – Type of Valves** For Isolation Saunder's Patented Diaphragm Valves For non-return / Check Swing Check type /Dual Plate type
		10.2 - Material of Construction Valves Diaphragm Valves a) Body shall be Cast Iron to IS: 210 Gr FG 260 /ASTM A 48 Cl.40; BS: 1452 Gr.220 OR Cast Steel to ASTM. A 216 GR. WCB b) For Diluted Sulfuric acid, body shall be Teflon lined/Alloy 20/Hastelloy C/Eqvt. c) Diaphragm shall be of reinforced TEFLON/ Equivalent. d) Stem, Compressor & Bush shall be Stainless steel Construction, Hand wheel shall be of Cast Iron Check Valves The complete valve shall be of Alloy-20/Hastelloy C / Equivalent
11.	Coagulant (Alum) and Coagulant aid Services	**11.1 – Type of Valves** For Isolation a) Saunder's Patented Diaphragm Valves b) Ball Valves in CPVC pipes For non-return / Check Swing Check type /Dual Plate type
		11.2 - Material of Construction Valves Diaphragm Valves a) Body shall be Cast Iron to IS: 210 Gr FG 260/ ASTM A 48 Cl.40 ; BS: 1452 Gr.220/ Equivalent. OR Cast Steel to ASTM. A 216

S.No	Service	Type of Valves / Material of Construction
		GR. WCB and Body shall be internally lined with Soft Natural rubber, Ebonite or Polypropylene b) Diaphragm shall be shall be of reinforced rubber /Hypalon/ approved equivalent c) Stem, Compressor & Bush shall be Stainless steel Construction <u>Ball Valves in CPVC Pipe lines</u> a) Body , Ball & stem shall be of CPVC b) Seat ring & Packing shall be EPDM / or equivalent <u>Check Valves</u> a) Body & Cover, Hinge Disk/Door shall be Cast Iron to IS: 210 Gr FG 260/ ASTM A 48 Cl.40; BS: 1452 Gr.220 or Eqvt and <u>shall be lined with natural Rubber, PTFE or Viton</u> or Stainless Steel – 316 b) Hinge Pin and Door/Disc Pin shall be of Cast steel ASTM A 216 Gr. WCB and <u>shall be coated with PVDF, or suitable elastomer</u> or Stainless Steel – 316 c) Disc facing ring and Body Seat rings shall be Stainless Steel d) Bearing bushes shall be SS – 316 e) Material of construction of spring in dual type valve shall be of INCONEL or better
12.	Lime slurry/Solution/ Suspensions	**12.1 – Type of Valves** <u>For Isolation</u> Non-lubricated Plug Valves <u>For non-return / Check</u> Swing Check type /Dual Plate type
		12.2 - Material of Construction Valves <u>Plug Valves</u> a) Body shall be Cast Iron to IS: 210 Gr FG 260 / ASTM A 48 Cl.40; BS: 1452 Gr.220

S.No	Service	Type of Valves / Material of Construction
		or Eqvt b) Plug shall be Stainless steel to AISI 316 c) Body Sleeve & Seat shall be PTFE d) Gland & Gland nut shall be SS 304/316 e) Cover shall be of Cast Steel to ASTM A 216 Gr WCB <u>Check Valves</u> a) Body & Cover, Hinge Disk/Door shall be Cast Iron to IS: 210 Gr FG 260 / ASTM A 48 Cl.40; BS: 1452 Gr.220 or Eqvt and <u>shall be lined with natural Rubber, PTFE or Viton</u> or Stainless Steel – 316 b) Hinge Pin and Door/Disc Pin shall be of Cast steel ASTM A 216 Gr. WCB and <u>shall be coated with PVDF, or suitable elastomer</u> or Stainless Steel – 316 c) Disc facing ring and Body Seat rings shall be Stainless Steel d) Bearing bushes shall be SS-316 e) Material of construction of spring in dual type valve shall be of INCONEL or better
13.	Coagulant Aid (Ferric Chloride), Anti-Oxidant & Anti- Scalant	**13.1 – Type of Valves** <u>For Isolation</u> a) Saunder's Patented Diaphragm Valves b) Ball Valves in CPVC pipeline <u>For non-return / Check</u> Swing Check type /Dual Plate type
		13.2 - Material of Construction Valves <u>Diaphragm Valves</u> a) Body shall be Cast Iron to IS: 210 Gr FG 260/ ASTM A 48 Cl.40; BS: 1452 Gr.220 OR Cast Steel to ASTM. A 216 GR. WCB/Eqvt. and Body shall be internally lined with Soft Natural rubber, Ebonite or Polypropylene or Stainless Steel

S.No	Service	Type of Valves / Material of Construction
		b) Diaphragm shall be of reinforced Neoprene/Hypalon/ approved equivalent c) Stem, Compressor & Bush shall be Stainless steel Construction. d) Hand wheel shall be of Cast Iron <u>Ball Valves in CPVC Pipe lines</u> a) Body , Ball & stem shall be of CPVC b) Seat ring & Packing shall be EPDM / or equivalent <u>Check Valves</u> The complete valve shall be of CPVC.
14.	Chlorine Gas	**14.1 -- Type of Valves** Needle Valve for shut off / Isolation and Angle type Needle Valve chlorine tonne container Isolation
		14.2 -- Material of Construction a) Body :Bronze(Silver plated)/Brass b) Needle : Monel c) Valve seat : Teflon / Monel d) Stem : Monel e) Gland/Gland nut : Bronze/ Brass f) Packing :Teflon
15.	Liquid Chlorine	**15.1 -- Type of Valves** Ball Valves for Isolation
		15.2 -- Material of Construction a) Body:Carbon Steel b) Ball :PVDF / Monel c) Stem:Stainless Steel AISI 316 L d) Bolts & nuts:AISI 316 L e) Gland / Gland nut: Bronze/ Brass f) Seat ring :PTFE

S.No	Service	Type of Valves / Material of Construction
16.	Chlorinated Water Service	**16.1 -- Type of Valves** a) Butterfly Type / Ball Valve in CPVC lines b) Saunder's Patented Diaphragm Valves in rubber lined steel pipes
		16.2 -- Material of Construction <u>Butterfly / Ball Valves</u> a) Body: CPVC b) Shaft: Carbon Steel Nickel plated c) Disc/ Ball Stem:CPVC d) Seating Rings:Viton e) Bush / O–ring (Butterfly type): PTFE <u>Diaphragm Valves</u> a) Body shall be Cast Iron ASTM A 48 Cl.40; BS: 1452 Gr.220 OR Cast Steel to ASTM. A 216 GR. WCB and shall be internally lined with Soft Natural rubber, Ebonite or Polypropylene b) Diaphragm shall be shall be of reinforced rubber /Hypalon/ approved equivalent c) Stem, Compressor & Bush shall be Stainless steel Construction d) Hand wheel shall be of Cast Iron
17.	Sludge	**17.1 -- Type of Valves** <u>For Isolation</u> Gate or Sluice or Knife edge type Slide Valves <u>For non-return / Check</u> Swing Check type /Dual Plate type
		17.2 -- Material of Construction <u>Gate / Sluice / Knife Edge Slide Valve</u> a) Body,Disc : Cast Iron b) Stem : Stainless Steel AISI 420 d) Packing : PTFE

S.No	Service	Type of Valves / Material of Construction
		e) Gland & Gland nut :AISI 420 f) Hand wheel :Cast Iron <u>Check Valves</u> a) Body & Cover, Hinge Disk/Door shall be Cast Iron BS:1452 Gr.220 or Eqvt b) Hinge Pin and Door/Disc Pin shall be of Cast steel ASTM A 216 Gr. WCB / High tensile Brass or BS: 2872 equivalent. c) Disc facing ring and Body Seat rings shall be Stainless Steel. d) Bearing bushes shall be Leaded tin Bronze. e) Material of construction of spring in dual type valve shall be of INCONEL or better
18.	Not used	-
		-
19.	Ion Exchange resin water slurry line (for resin transfer application)	**<u>19.1 Type of Valves</u>** a) Two way eccentric plug valve as manufactured by DeZerik or approved equal b) Ball valves of full bore type. **19.2 Material of Construction** The complete valve shall be of stainless steel construction (AISI-316)
		-
20.	Back wash/Rinse water (from discharge of back wash water pumps)	**<u>20.1 Type of Valves</u>** Same as specified under 6.1 above **<u>20.2 -- Material of Construction</u>** Same as specified under 6.2 above
21.	Waste effluent (neutralized)	**<u>21.1 Type of Valves</u>** Same as specified under 6.1 above

S.No	Service	Type of Valves / Material of Construction
		21.2 -- Material of Construction Same as specified under 6.2 above

C. Other Requirements:

a) Valves for liquid and gas service on the chlorine supply side of the installation shall be as per approved design of the chlorine Institute, USA.

b) Butterfly valves shall conform to design standard latest revision of AWWA C-504/EN 593/equivalent standard of required class/rating.

c) Plug valves shall be designed as per BS: 5353 Cl.150 or equivalent.

d) Valves for alum solution shall be Saunders's patented Diaphragm type designed as per BS: 5156 or approved equivalent standard

e) For UF and RO Plant application, stainless steel piping (SS-304) shall be used for the high pressure piping and the industrial grade CPVC as per ASTM F441 CPVC 4120 Sch. 80 piping shall be used for low pressure areas.

f) Sluice/Gate Valves shall conform to BS: 5150 (BS: 5163 PN 16) PN16, IS: 14846 of rating PN 1.6 (min.). Stem, seat ring and wedge facing ring shall be of stainless steel construction. Other parts shall be as per IS: 14846 /BS: 5163). Flanges shall be designed as per ANSI B 16.5 Cl. 150 (min.) to meet with the piping flanges. Valves shall be of outside screw and rising stem type. Gate valves for sizes below 50 NB and below shall conforms to IS: 778 Class-2/ANSI B16.34 straight, rising stem; without side screw.

g) Sluice/Gate valves shall be provided with the following accessories in addition to the standard items:

   1) Hand wheel
   2) Manual Gear reduction unit operator for valves 200 NB and above
   3) Bypass valve for valve of sizes 350 NB and above.
   4) Draining arrangement wherever required.
   5) Arrow indicating flow direction.
   6) Position indicator.
   7) Sluice/Gate Valves shall be provided with back seating bush to facilitate gland renewal during full open condition.

h) Design standard for Gates shall be IS: 3042 or Equivalent.

Material of Construction

1) Frame and Door : Cast Iron IS:210 Gr.260

2) Spindles, bolts & nuts:M.S. to IS:2062

3) Face & seat rings:Gun metal (as per IS: 3042).

i) All the parts of gates shall be applied with the coats of heavy duty bitumastic paint. Each of the gates shall be provided with hand wheel and a position indicator. The gates for DM plant drains shall be rubber lined to a minimum thickness of 4.5 mm.

j) Sluice valve/knife edge type slide valves shall design by IS 14846. Plug valves shall be used for the application of lime slurry/lime solutions conforming to BS: 5353 Class 150 or Equivalent..

a) Valves will be used to start/stop or control flow. Gates will be primarily used for isolation of flow in open channels although these should be capable of throttling the flow too. However, contractor can provide either isolation gates or butterfly valves in various RCC tanks/pits/sumps such as sludge pit, filter backwash pit, waste service water sump, coal decanted water sump, clarified water storage tank, service water tank, CMB etc. Sample valves will be used in sample collection lines. Unless otherwise specified all the valves shall be supplied with counter flanges by the Contractor.

b) All valves shall be suitable for service conditions i.e. flow, temperature and pressure under which they are required to operate. All the valves shall be of standard pressure rating of the relevant design standard. Nonstandard pressure rating shall not be accepted. The pressure and temperature rating of the valve shall not be less than the maximum expected pressure and temperature plus 5% additional margin of the system in which valves are proposed to be installed. The pressure rating of individual piping system component such as valves, flanges etc. shall however be not less than that specified.

26.00.00 **DESIGN FEATURES OF "PRESSURE AND STORAGE VESSELS"**

1) Design of all pressure vessels shall conform to ASME Section VIII or acceptable equivalent standard. Design pressure shall be the maximum expected pressure to which the vessels may be subjected to plus 5% additional margin. Maximum expected pressure for vessels placed in the discharge line of pumps shall be based on the shut-off head of the pumps plus static head at pumps suction if any. For all other pressure vessels, design pressure shall be at least 8 Kg/cm² (g).

2) Design of all vertical cylindrical atmospheric storage tanks containing water, acid, alkali and other chemicals shall conform to IS: 803.

3) Design of all horizontal cylindrical atmospheric storage tank containing water, acid, alkali and other chemicals shall conform to BS: 2594.

4) Design temperature of all pressure vessels and storage tanks shall be 10 deg. C higher than the maximum temperature that any part of the

vessel/tank is likely to attain during operation. In case, tank is subjected to vacuum, the same shall be taken care in designing the tank.

5) The design of DM water storage tanks (Vertical type) shall conform to IS: 803. Supporting frame where required shall be in accordance with IS: 800. The tank shall be "Non-pressure" fixed roof type with atmospheric vents.

6) All vessels/tanks without inside rubber lining shall have a corrosion allowance of minimum 2 mm and mill allowance (minimum 0.3 mm) for shell and dished ends. Thinning allowance of 2 mm (minimum) shall be considered for dished end.

7) All the atmospheric tanks shall have sufficient free board above the “Level High”/ “Normal Level” as the case may be. The overflow level shall be kept at least 20 cm or 10% of vessel height above the “Level High”/”Normal Level” for all the tanks except for the DM tanks for which a minimum height of 300 mm shall be provided over the “High Level”. Further, a minimum 100 mm free board shall beprovided above the top of overflow level to the bottom of roof of the tank. Wall thickness of atmospheric tanks shall not be less than 6 mm.

8) Vessels coming under preview of IBR shall be designed accordingly.

9) **Material of Construction**

i) The pressure vessels shall be fabricated from carbon steel plates conforms to SA 515 Gr.70 or SA 516 Gr. 70 if the pressure vessels are designed as per ASME Section VIII.

ii) If the pressure vessels are designed as per IS 2825 following criterion shall be followed: The pressure vessels shall be fabricated of steel as per IS: 2002 Gr. 3 (normalized condition) or SA: 515/516 Gr. 70 (normalized), in case the vessels are designed as per Class 1 or Class 2 of IS: 2825. If the pressure vessels are designed as per Class 3 of IS: 2825, the material of construction shall conform to IS: 2062 or IS: 2002 Gr. 3 (Normalized quality).or SA 515 /516 Gr. 70

iii) All atmospheric tanks shall be fabricated of steel conforming to IS: 2062.

iv) The pipe flanges, manhole/manhole covers reinforcement pads etc. shall be fabricated out of the same material as that one used for the vessel/tank.

10) **Fabrication**

a) The vessel ends for storage tanks of vertical type shall have flat bottom. However, the ends of horizontal storage tanks, and all the pressure vessels shall be dished design of Torispherial type designed and constructed by forging, pressing or spinning. The dished ends shall have a minimum straight flange length of 60 mm. Conical or flat (with or without reinforcement) ends shall not be accepted.

b) The plates to be used for fabrication shall preferably have a minimum width of 1500 mm. All welding shall be performed by ASME qualified welders under Section-IX of ASME Boiler and Pressure Vessel code and welding electrodes shall be as per relevant Codes/Standards viz. AISC Section 1.17 etc.

c) All pressure vessels and storage tanks except DM water storage tanks, UF, RO Permeate water tanks shall be fabricated complete and tested at manufacturer's works to ensure better workmanship.

11) **Appurtances, Connections, Lifting lugs**

a) Manholes/Hand Holes: All the pressure vessels and horizontal type storage tanks shall be provided with at least one manhole of 500 mm diameter. The vertical type storage tanks shall be provided with a manhole of 500 mm dia on the top cover, if the diameter of the tank is 1200 mm or more. For the vertical cylindrical atmospheric tanks, manholes shall be provided as per IS: 803.

b) All the vessels and tanks shall be normally provided with a hand hole of 150 mm gasketted located near the bottom of the straight side.

c) All lined vessels connections shall be conform to required class/rating. Nozzle material shall be ASTM-106 Grade B, Schedule 80.

d) All vessels of internal, diameter of 1200 mm or greater shall be provided with minimum four (4) lifting lugs for safe and effective handling during erection. Smaller vessels shall be provided with at least two (2) lifting lugs. Material of construction for these vessel supports, saddles, lugs shall conform to IS: 2062 of tested quality.

27.00.00 Painting: Painting shall be conform to the requirements specified elsewhere in technical specification.

GENERAL TECHNICAL REQUIREMENT OF LOW PRESSURE PIPING

EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-1 (3x800 MW)	TECHNICAL SPECIFICATION SECTION-VI PART-A BID DOC NO: CS-9585-001-2

1.00.00 LOW PRESSURE PIPING

1.01.00 The Scope of Low Pressure (LP) piping systems for the following services shall be as defined in various tender drawings & the sub section pertaining to "Terminal points and exclusions" and shall include the following systems:

a) DM water normal make-up system (condenser makeup, ECW makeup for both Steam Generator and Turbo Generator Auxiliaries, make-up to H2 generation plant & CPU regeneration plant etc.)

b) Condenser emergency make up and ECW tank emergency make-up for SG & TG / condensate storage and transfer system.

c) Boiler (Steam Generator) and Deaerator fill system.

d) Equipment Cooling Water (ECW) system including its chemical dosing system for primary circuit for Steam generator and Turbo generator and their auxiliaries.

e) Auxiliary cooling water system.

f) Complete service water system, APH /ESP wash water system, Drinking (potable) water system, clarified water system & HVAC – system, Raw water system (PT plant and ash handling) , other applicable systems mentioned elsewhere in the specification

g) Instrument Air System.

h) Service (plant) Air System.

i) Drain piping system for the piping\equipment etc. under the bidder's scope.

j) Tanks as described elsewhere in the specification for the above systems. (Including condensate storage tanks etc.).

k) Re-circulation pipes along with valves, breakdown orifices etc., wherever required/specified elsewhere in Technical Specification.

l) Any other piping system required making the Low Pressure (LP) piping systems in the bidder's scope complete.

1.02.00 The scope covers the following for the complete LP piping systems mentioned above:

a) Design, engineering, manufacturing, supply, fabrication, testing packaging, transportation to site, storage, taking delivery of Employer supplied equipment from site stores, in plant transportation, erection, cleaning, testing and commissioning of all items i.e., pipes, fittings, supports/ hangers, valves, actuators, motors, specialties, expansion joints, strainers, moisture traps, tanks, chemical dosing system for Equipment Cooling Water System (Primary circuit), instruments, drains, vent including drain/ vent valves ,air release valves etc.

The items though not specifically mentioned or indicated here in but are needed to make the system / equipment complete shall also be furnished and treated as if included in the specification unless otherwise specifically excluded.

1.03.00 Bidder's scope of supply & works shall include but not be limited to the following:

a) Pipes, headers and manifolds, bends, elbows, returns, tees, laterals, crosses, reducers/ expanders, caps and closures, couplings, plugs, sleeves, and saddles, stubs and bosses, unions and other similar fittings, flanges, gaskets, fasteners and sealants, ring joints, backing rings, all types of valves including drain/ vent/ air release valves, 3-way valves(where applicable) with test connection for instruments/ manifolds etc.actuators, specialties, orifices, flow nozzles, etc. as per finalized single line flow diagrams and layout drawings/ isometric drawings.

b) Complete assemblies of hangers, supports anchor, guides, restraints, etc. including welded attachments, clamps, devices tie-rods, turn-buckles, springs and spring cages, shoes, rollers, trapezes etc.

c) Weather hoods for pipes crossing ceilings and walls.

d) Instrument tapping and stub connections, root valves, 3-way valves (where applicable) with test connections, drains and vent valves & expanders / reducers as required and instruments as indicated else where for instruments supplied by the Contractor..

e) Drain funnels, drip pans, moisture traps etc. where ever required shall be provided.

f) Instrument tapping, stub connections, root valves and instrument tubing up to root valves for instruments supplied by the Employer for onward connections by the Employer.

g) All supporting attachments like plates, saddles, stools, shoes, base plate, saddle plates, angles, channels, I-beams, trapeze, cantilevers, brackets, sways, braces, nuts, bolts, cleats, clamps, needed to complete the erection of piping system covered under this specification.

Anchor bolts, bed & foundation plates, pipe sleeves and Nuts to be embedded in concrete for piping where ever indicated in the drawing. All grouting and chipping work (including supply of cement, sand and stone chips) for equipment foundations, pipe supporting etc.

Reinforced concrete valve chambers wherever required for underground piping.

h) Surface preparation, priming and painting of all non-insulated above ground piping and equipment except galvanized steel piping & surfaces , stainless steel piping & surfaces, and gun metal surfaces.

Paints and varnishes, primers, thinners etc. as required for anti-corrosive protection of piping & equipment above ground.

i) Bidder shall provide anti-corrosive protection anticorrosive tape or coating-wrapping on the external surfaces of pipes to all directly buried piping including galvanized carbon steel piping.

j) On the internal surface of all pipes 1000 mm and above, a coat of primer followed by a hot coat of coal tar enamel paint or coal tar epoxy paint shall be applied.

k) Excavation, preparation of bed, backfilling with compaction of soil and removal of extra-earth to designated places in case of pipes to be buried.

l) Bidder shall also design, supply, fabricate, erect, set and commission all hangers, tie-rods, turn-buckles, supports, guides, restraints, anchors, etc. as required for the, piping system. This includes the provision of all associated steel work including brackets, cradle supports, duck foots, channels, angles, etc. It is Bidder's responsibility to estimate these requirements and include them in their offer price. Whenever, straight run of the yard pipes are more than 300 meters, flexibility analysis shall be conducted by the contractor to identify the requirement of loops, type of supports etc.

m) In covered concrete trenches bidder shall supply necessary supporting materials such as stools, saddles, base plates, clamps, U-bolts, angles, clips etc.

n) Bidder shall supply all necessary drains and vents with drain & vent valves including anti-flash funnels and moisture traps for compressed air system as required for the safe and effective draining-venting of the piping systems based on the approved flow scheme / single line diagram. It is bidder's responsibility to identify the requirements of drains, vents, and supply the necessary pipe work, fittings, hangers and supports etc. for the same.

o) Bidder shall supply and install necessary matching pieces as may be needed for connection of piping systems with equipment terminals, valves and specialties.

p) Bidder shall erect all instrument impulse piping and fittings from the tap-off point of the last root valve including the root valve and instruments.

q) Bidder shall perform necessary internal machining of pipe for installing orifices, flow nozzles, straightening vanes etc.

r) The Bidder shall prepare the flow diagrams, detailed dimensional piping layout/ Isometric/ fabrication/ As built drawings of all the systems along with Cross sectional drawings, showing all supports and equipment as required.

s) In addition to submission of drawings as stipulated above bidder shall also furnish the data/ documents with respect to following:

1) Thickness calculation of large diameter buried pipes as per AWWA-M-11.

2) System design calculation of Primary closed circuit ECW and secondary circuit ACW system for flow & pressure balancing.

3) Design calculations for condensate storage tank and Drinking water tank.

4) Static Analysis for Long (more than 300 metre straight run) above-ground piping wherever required.

t) Bidder's scope of supply for fabrication, erection, cleaning, testing and commissioning of the piping systems installed by him shall include the following:-

All welding consumables like welding electrodes, filler rods and wires; gases like oxygen, acetylenes, argon, carbon-dioxide, propane, backing rings etc.

Films for radiographic examination of welds.

X-ray and Gamma -ray equipment including isotopes, dye penetrants, and other required non-destructive testing materials and equipment (all to be taken back by the Bidder after completion of work).

All heating and stress relieving equipment, thermocouples asbestos blankets, cables, temperature recorders, charts heat sensitive chalks and crayons etc. (All to be taken back by bidder after completion of work).

All machinery, equipment tools and tackles as required for transportation handling, fabrication and erection (All to be taken back by Bidder after completion of work).

All equipment/ materials as required for cleaning, flushing, blowing out and hydro testing of the piping systems; these shall include but not be limited to pumps and compressors with prime movers, instruments, pipe work with supports, valves, strainers and other specialties, blanks, plugs, spool pieces, dummy plates, electrical accessories, etc. (All to be taken back by Bidder after completion of work).

All scaffolding materials and false work (To be taken back by Bidder after completion of work).

1.04.00 The Bidder shall provide Services of erection superintendent and foremen, fitters and riggers, welders, transport and crane operators and other skilled and unskilled labour.

The design engineering and providing all temporary pipe work as required for erection, cleaning, flushing, blowing out, testing and commissioning of the piping system is the responsibility of the Bidder.

The Bidder's scope shall include design, supply of required structural steel (except those which are specifically excluded), their fabrication and erection where ever required.

GENERAL TECHNICAL REQUIREMENT OF LOW PRESSURE PIPING (CONT.)

LOW PRESSURE PIPING

1.00.00 EQUIPMENT SIZING CRITERIA

1.01.00 All the piping systems and equipment supplied under this package shall be designed to operate without replacement and with normal maintenance for a plant service life of 30 years, and shall withstand the operating parameter fluctuations and cycling which can be normally expected during this period.

1.02.00 For all Low Pressure piping systems covered under this specification, sizing and system design shall be to the requirements of relevant codes and standard indicated. In addition to this, requirements of any statutory code as applicable shall also be taken into consideration.

1.03.00 Inside diameters of piping shall be calculated for the flow requirements of various systems. The velocities for calculating the inside diameters shall be limited to the following:

a) **Water Application**

	Pipe Size	Water Velocity in m/sec Below 50 mm	50-150 mm	200 mm & above
(a)	Pump suction	------	1.2-1.5	1.2-1.8
(b)	Pump discharge and recirculation	1.2-1.8	1.8-2.4	2.1-2.5
(c)	Header	------	1.5-2.4	2.1-2.4

Pipe line under gravity flow shall be restricted to a flow velocity of 1 m/sec generally. Channels under gravity flow shall be sized for a maximum flow velocity of 0.6 m/sec.

WILLIAM & HAZEN formula shall be used for calculating the friction loss in piping systems with the following "C" value:

(i)	Carbon steel pipe	100
(ii)	Ductile Iron.	140
(iii)	Rubber lined steel pipe	120
(iv)	Stainless steel pipe	100

For calculating the required pump head for pump selection, at least 10% margin shall be taken over the pipe friction losses and static head shall be calculated from the minimum water level of the tank/ sump/ reservoir from which the pumps draw water.

(b) **Compressed Air Application**

Compressed air 15.0 m/sec.(under Average Pressure & Temp. conditions)

1.04.00 The pipes shall be sized for the worst (i.e. maximum flow, temp. and pressure values) operating conditions.

1.05.00 Based on the inside dia. so established, thickness calculation shall be made as per ANSI B 31.1 OD and thickness of pipes shall than be selected as per ANSI B 36.10/IS-1239 Heavy grade/IS-3589/ASTM-A-53/API-5L/ANSI B 36.19 as the case may be.

1.06.00 Corrosion allowance of 1.6 mm will be added to the calculated thickness being considered (except stainless steel piping).

1.07.00 Bend thinning allowance/manufacturing allowance etc. shall be as per the requirement of the design code provision.

1.08.00 High points in piping system shall be provided with vents along with valves as per the system requirement. Low points shall be provided with drains along with drain valves as per the system requirement. Drain lines shall be adequately sized so as to clear condensate in the lines. Material for drain and vent lines shall be compatible with that of the parent pipe material.

1.09.00 Material of construction for pipes carrying various fluids shall be as specified elsewhere.

1.10.00 Compressed air pipe work shall be adequately drained to prevent internal moisture accumulation and moisture traps shall be provided at strategic locations in the piping systems.

1.11.00 Depending upon the size and system pressure, joints in compressed air pipe work shall be screwed or flanged. The flange shall be welded with the parent pipe at shop and shall be hot dip galvanized before dispatch to site. Alternatively, the flanges on GI pipes may be screwed-on flanges also.

1.12.00 Threaded joints shall be provided with Teflon sealant tapes.

1.13.00 Following types of valves shall be used for the system/service indicated.

SYSTEM	**TYPES OF VALVES**					
	Butterfly	Gate	Globe	Check	Ball	Plug
Water	x	x	x	x	x	
Air		x	x	x	x	
Drains & vents		x	x	x		
Fuel oil (if any)		x	x	x	x	x

1.14.0 Recirculation pipes along with valves, breakdown orifices etc. shall be provided for important pumping systems as indicated in respective process and instrumentation diagrams (P&IDs). The recirculation pipe shall be sized for minimum 30%design flow of single pump operation or the recommended flow of the pump manufacturer whichever is higher.

2.00.00	**TECHNICAL SPECIFICATION**
2.01.00	**GENERAL**
	Specific technical requirements of low-pressure piping, fittings, supports, valves, specialties and tanks etc. have been covered under this Sub-section. It includes details pertaining to design and material of construction for piping, fittings, valves, equipment, etc. cleaning/surface preparation application of primer and painting on over ground piping. It also includes detailed technical requirement of laying underground/buried piping including water proofing/anti corrosive protection. It also covers design, engineering, manufacturing, fabrication, technical details of piping, valves, specialties, piping hangers / supports, tanks etc.
2.02.00	**Pipes and fittings**
2.02.01	All low pressure piping systems shall be capable of withstanding the maximum pressure in the corresponding lines at the relevant temperatures. However, the minimum thickness as specified in the following clauses and or respective codes for pipes and fittings shall be adhered to. The bidder shall furnish the pipe sizing/ thickness calculation as per the criteria mentioned above under LP piping equipment sizing criteria of this Technical Specification.
2.02.02	Piping and fittings coming under the purview of IBR shall be designed satisfying the requirements of IBR as a minimum.
2.02.03	Supporting arrangement of piping systems shall be properly designed for systems where hydraulic shocks and pressure surges may arise in the system during operation. Bidder should provide necessary protective arrangement like anchor blocks/anchor bolt etc. for the safeguard of the piping systems under above mentioned conditions. The requirement will be, however, worked out by the contractor and he will submit the detailed drawings for thrust/anchor block to the Employer. External, and internal, attachments to piping shall be designed so as not to cause flattening of pipes and excessive localized bending stresses.
2.02.04	Bends, loops, off sets, expansion or flexible joints shall be used as required in order to prevent overstressing the piping system and to provide adequate flexibility. Flexibility analysis (using software packages such as Caesar-II etc.) shall be carried out for sufficiently long piping (straight run more than 300M).
2.02.05	Wherever Bidder's piping coming under this specification, terminates at an equipments or terminal point not included in this specification, the reaction and the thermal movement imposed by bidder's piping on equipment terminal point shall be within limits to be approved by the Employer.
2.02.06	The hot lines shall be supported with flexible connections to permit axial and lateral movements. Flexibility analysis shall be carried out for pipelines which have considerable straight run as indicated above and necessary loops/ expansion joint etc. shall be provided as may be necessary depending on layout.
2.02.07	Piping and fittings shall be manufactured by an approved manufacturer of repute. They should be truly cylindrical of clear internal diameter, of uniform thickness, smooth and strong, free from dents, cracks and holes and other defects.
2.02.08	For rubber lined ERW pipes, beads shall be removed.
2.02.09	Inspection holes shall be provided at suitable locations for pipes 800 Nb and above as required for periodic observations and inspection purposes.

2.02.10 At all intersection joints, it is Contractor's responsibility to design and provide suitable reinforcements as per the applicable codes and standards.

2.02.11 For large size pipes/ducts, at high point and bends/change of direction of flow, air release valves shall be provided as dictated by the system requirement and operation philosophy & tripping conditions of pumping system. Sizing criteria for air release valves shall be generally on the basis of valve size to pipe diameter ratio of 1:8. Requirement shall be decided as per relevant code.

Transient analysis /surge analysis where ever specified and required shall be conducted in order to determine the location , number and size of the Air-Release valve on certain long distance/high volume piping systems, if applicable within the scope of work of the package.

2.03.00 **Material**

2.03.01 Alternate materials offered by Bidder against those specified. shall either be equal to or superior to those specified, The responsibility for establishing equality or superiority of the alternate materials offered rests entirely with the Bidder and any standard code required for establishing the same shall be in English language.

2.03.02 No extra credit would be given to offers containing materials superior to those specified. Likewise no extra credit would be given to offers containing pipe thickness more than specified.

2.03.03 All materials shall be new and procured directly from the manufacturers. Materials procured from traders or stockists are not acceptable.

2.03.04 All materials shall be certified by proper material test certificates. All material test certificates shall carry proper heat number or other acceptable references to enable identification of the certificate that certifies the material.

2.03.05 Material of construction for pipes carrying various fluids shall be as follows:

Sl No	Type of Fluid	Material
1.	i) Ordinary Water (Raw Water, Clarified Water, etc.) ii) Equipment cooling water including Both primary & secondary circuit (DMCW pH-corrected & ACW drain water)	IS-2062 Gr.-E-250B/ASTM A-36/ASTM A-53 type 'E'Gr.B/IS-3589 Gr. 410 /IS-1239 Heavy.
2.	i) Demineralised water, ii)Alkaline solution (ECW system chemical dosing)	Stainless Steel to ASTM A312, Gr. 304 welded for sizes 65 mm NB and above. Stainless steel to ASTM A312, Gr. 304 sch.40s seamless for sizes 50mm and below
3.	i) Drinking (potable) water ii)Compressed air (Instrument & service air)	ASTM A-53 type E Gr. B galvanized/ IS 1239 Gr heavy galvanized/IS 3589 Gr 410 galvanized. Galvanized shall be to IS- 4736 or equivalent.
4.	(Condensate) spill water	ASTM A 106 Gr. B
5.	Effluents from Neutralization pit	MSRL

2.03.06	In water lines, pipes upto 150mm Nb shall conform to ANSI B36.10/ASTM-A-53, Type-E Gr.B /IS:1239 Gr. Heavy and minimum selected thickness shall not be less than IS:1239 Grade Heavy except for demineralised water, drinking water and condensate spill lines.
2.03.07	Pipes of above 150mm Nb shall be to AWWA-C200/ANSI B 36.10/ASTM A-53/IS 3589 Gr.410. Pipe to be fabricated by the bidder shall be rolled and butt welded from plates conforming to ASTM A-53 type 'E' Gr. B/IS 2062 Gr.E-250B/ASTM-A-36. However, larger pipes, i.e. 1000mm Nb and above shall be made from plates conforming to ASTM A 36/IS 2062 Gr.E-250B and shall meet the requirements of AWWA-M-11 (for deflection & buckling criteria considering water filled pipe as well as vacuum condition that may prevail during transient/surge conditions, truck-load, rail-load and weight density for compacted soil or any other load as the case may be).
2.03.08	In demineralised water service, the pipes upto 50 Nb shall be of stainless steel ASTM A 312, Gr. 304 sch. 40 Seamless. The size for these pipes shall be to ANSI B 36.19. These shall be socket welded. The material for pipe from 65mm NB upto and including 400 NB shall be to ASTM A 312, Gr. 304 (welded). In no case the thickness of fittings shall be less than parent pipe thickness. Bidder/Contractor shall note that pipes offered as per a particular code shall conform to that code in all respects i.e. Dimension, tolerances, manufacturing methods, material, heat treatment, testing requirements, etc. unless otherwise mentioned elsewhere in the specification.
2.03.09	Instrument air, Plant (service) air lines and Drinking water lines shall be to ASTM A 53 type E grade B/ANSI B 36. 10/IS 3589, Gr. 410 / IS: 1239 Heavy (in case thickness calculated is more than gr. Heavy, ANSI B 36.10 Schedule numbers shall be followed) and galvanized to IS 4736 or any equivalent internationally reputed standard. The material of the pipes shall be to ASTM A 53 type 'E' Gr. B / IS: 3589, Gr. 410 / IS: 1239 Gr. Heavy. The fittings shall be of either same as parent material or malleable iron to IS-1879 (galvanized).
2.03.10	Spiral welded pipes as per API-5L/IS-3589 are also acceptable for pipe of size above 150 NB. However minimum thickness of the pipes shall be as elaborated in above clauses.
2.03.11	Condensate lines shall be to ASTM A 106 Gr. B and dimension to ANSI B 36.10 schedule "standard" as minimum to be maintained.
2.03.12	If carbon steel plates of thickness more than 12 mm are used for manufacture of pipes, fittings and other appurtenances, then the same shall be control-cooled or normalized as the case may be following the guidelines of the governing code.
2.04.00	**Field routed pipes:**
2.04.01	Pipe lines of NB 50 size and below are regarded as field run piping. It is Bidder's responsibility to plan suitable layouts for these system insitu. Bidder shall prepare drawings indicating the layout of field run pipe work. These drawings shall be approved by Project Manager to the installation of the field run pipe work. Based on these approved layouts the Bidder shall prepare the BOQ of field run-pipes and submit to Employer for approval.
2.05.00	**Slope/Drains and Vents**
2.05.01	Suitable slope shall be provided for all pipelines towards drain points. It is Bidder responsibility to identify the requirements of drains and vents, and supply the necessary pipe work, valves, fittings, hangers and supports etc. As per the system requirement low points in the pipelines shall be provided with suitable draining arrangement and high points shall be provided with vent connections where air or gas pockets may occur. Vent for use during hydrostatic test shall be plugged after the completion of the test. Vent shall not be less than 15mm size. Drains shall be provided at low points and at pockets in piping such that complete drainage of all systems is possible. Drain shall not be less than 15mm for line size

up to 150mm, not less than 20mm up to 300mm and not less than 25mm for 350mm to 600mm pipes and not less than 50mm for 600mm and above pipes.

2.05.02 Air piping shall be sloped so that any part of the system can be drained through the shut-off drain valve or drain plugs.

2.06.00 **Pipe Joints**

In general all water lines 65mm NB and above, are to be joined generally by butt welding except the locations where valves/fittings are to be installed with flanged connections and 50mm and below by socket welding unless mentioned otherwise specifically. All air lines shall be of screwed connection and rubber lined pipes of flanged connections.

2.06.01 **Screwed Joints**

(a) Threading of pipes shall be carried out after bending, heat treatment etc. If not possible, threading may be done prior to these operations but proper care should be taken to protect them from damage. Threads shall be to ANSI B 2.1 (taper) NPT/IS: 554 unless specified otherwise.

(b) Galvanized pipe shall generally be joined by screwing into sockets. The exposed threaded portion on the outside of the pipes shall be given a zinc silicate coating. Galvanized pipes shall not be field joined by welding for protection of Galvanising Zinc layer. Screwed ends of GI pipes shall be thoroughly cleaned and painted with a mixture of red and white lead before jointing. For galvanized pipe sizes above 150 mm NB, screw & socket jointing as per ASTM-A-865 shall be employed for both pipe-to-pipe and pipe-to-fitting jointing. For pipe to fitting connection since no direct threading can be done on the fittings (supplied as per ASTM-A-234 Gr. WPB and ANSI B-16.9) necessary straight pipe lengths acting as match pieces shall be welded to the fitting at both ends and subsequently the free ends of the straight lengths shall be threaded as per ASTM A-865 for jointing with main pipe. Once welding of fittings with match pieces and threading of free ends of match pieces are over, the entire fabricated piece shall be galvanized, or in case match pipes and fittings are already galvanized before the above mentioned fabrication then suitable application of Zinc-Silicate paste adequately at the welded surface (both in side & out side) after welding with zinc rich electrode, along with the nascent threaded metal portions at both free ends given the same application of Zinc Silicate paste. Alternatively flanged jointing may be employed for pipe sizes 100 NB and above. However, the bidder shall ensure the galvanized pipe joints do not fail during hydro test.

(c) Teflon tapes shall be used to seal out screwed joints and shall be applied to the male threads only. Threaded parts shall be wiped clean of oil or grease with appropriate solvent if necessary and allowing proper time for drying before applying the sealant. Pipe ends shall be reamed and all chips shall be removed. Screwed flanges shall be attached by screwing the pipe through the flange and the pipe and flange shall be refaced accurately.

(d) For pipe sizes from 350 mm NB to 550 mm NB (including 350 NB & 550 NB) the GI pipes shall be of flanged connection. However, the pipes after welding of flanges shall be completely galvanized. Any site welding done on galvanized pipes shall be done with zinc-rich special electrodes and the welded surfaces whether inside or outside shall be coated with zinc-silicate paste. Seal welding of flanges with zinc-rich electrode will be permitted only when any flange is leak-prone during hydro testing.

(e) For pipe sizes 600 mm NB and above, the GI pipes shall be of welded connection (with zinc-rich special electrodes) followed by application of zinc silicate coating at welded surfaces both inside and outside the pipe, except for the last blank/blind flange, or, equipment connection where application of zinc-silicate paste after welding cannot be done due to inaccessibility of the inside welded surface and where

galvanic protection has been impaired due to welding of pipe-to-pipe joint. Thus the last erection joint shall be flanged joint.

2.06.02 **Welded Joints**

(a) For making up welded joints (butt weld or socket weld) the welding shall be performed by manual shielded metal arc process in accordance with the requirements specified elsewhere in the spec. Any welder employed for carrying butt welding shall be qualified as per ASME section IX for the type of joints he is going to weld. Jointing by butt weld, or socket weld shall depend upon the respective piping material specifications.

2.06.03 **Flanged Joints**

(a) Flanged connections for pipes are to be kept to the minimum and used only for connections to vessel, equipments, flanged valves and other fittings like strainer/traps/orifices etc. for ease of connection and maintenance etc. Rubber lined pipes shall be flange joined only.

(b) All flanged valves intended for installation on steel piping system, shall have their flanges drilled to ANSI B 16.5 (or equivalent) and according to the pressure class stated in their respective piping material specification.

(c) Drilling on flanges of flanged valves must correspond to the drilling of flanges on the piping system on which the valves are installed.

2.07.00 **Bends/elbows/mitre bends/ Tees/ Reducers & other fittings**

2.07.01 For pipe fittings such as elbows (long radius), reducers, tees, etc. the material shall be to ASTM-A-234 Gr. WPB/ASTM-105 up to 300 NB. For pipe fittings above 300 NB, the fittings may be fabricated conforming to parent pipe material. Provision of compensation pads shall be kept as per ANSI B 31.1. The fitting shall conform to the dimensional standard of ANSI B-16.9/ 16.11.Further branching in pipes for sizes 65nb and above is also acceptable (ANSI B 31.1).

However, for pipes up to 150 NB, pipe fittings may be supplied with material and dimension conforming to IS 1239 in case parent pipes also conform to IS 1239.

2.07.02 For pipe size 350Nb and above mitre bends may be used for all pipes except rubber lined pipes. The bend radius shall be 1½ times the nominal pipe diameter. 90 deg. bends (mitre) shall be in 4 pieces (3 cuts) and 45 deg. mitre bends shall be in 3 pieces 22½ deg. Fabrication of mitre bends shall be as detailed in BS 2633/BS534.

2.07.03 For pipes, above 1200 NB, reducer and tees shall be to dimensional standard of AWWA-C-208.

2.07.04 Stainless steel fittings shall conform to either ASTM-A-182 Gr. 304 or ASTM-A-403 Grade WP. 304 Class-S, for sizes upto and including 50 mm NB, i.e. the fittings shall be of seamless construction. However, for stainless fittings above 50 mm NB, the same shall conform to ASTM-A-403 Gr. WP 304 Class W i.e. the fittings shall be of welded construction strictly in accordance with ASTM-A-403.

2.07.07 In no case, the thickness of fittings shall be less than the thickness of parent pipe, irrespective of material of construction.

2.08.00 **Flanges**

2.08.01 Flanges shall be slip on type. Welding of flanges in tension is not permitted.

2.08.02 All flanges and-flanged drilling shall be to ANSI B 16.5/BS EN-1092 of relevant pressure/temperature class. Flanges shall be fabricated from steel plates conforming to ASTM A 105/IS 2062 Gr. E-250B. However stainless steel flanges shall be fabricated from SS plates to ASTM-A-240, Gr. 304 or equivalent.

2.09.00 **Specific technical requirement of laying buried pipe with anti corrosive treatment**

The pipe in general shall be laid with the top of the pipe minimum 1.0 (one) meter below finished general ground level.

2.09.01 **Trenching**

(a) The trench shall be cut true to the line and level and shall follow the gradient of the pipeline. The width of the trench shall be sufficient to give free working space on each side of the pipe. Trenches shall conform to IS 5822 or any international standard.

2.09.02 **Preparation and cleaning of piping**

(a) The pipeline shall be thoroughly cleaned of all rust, grease, dirt, weld scales and weld burrs etc. moisture or other foreign matter by power cleaning method such as sand or grit blasting, power tool cleaning, etc. Grease or heavy oil shall be removed by washing with a volatile solvent such as gasoline. Certain inaccessible portions of the pipeline (which otherwise not possible to be cleaned by power cleaning methods) may be scrubbed manually with a stiff wire brush and scrapped where necessary with specific permission of the Project Manager.

(b) On the internal surface for pipes 1000 Nb and above, a coat of primer followed by a hot coal-tar enamel or coal tar epoxy painting (cold) shall be applied.

2.09.03 **Coating and wrapping/ Anti corrosive Protection Coal tar tape**

a. Buried piping shall be coated and wrapped, as per specification, after completion of welded and/or flanged connections, and after completion and approval of Hydro testing. Materials to be used for coating and wrapping of underground pipelines are:

(1) Coating primer (coal tar primer)

(2) Coating enamel (coal tar enamel)

(3) Wrapping materials.

All primer/coating/wrapping materials and methods of application shall conform to IS: 10221 except asphalt/bitumen material. Materials (primer/coating/wrapping) as per AWWA-C-203 are also acceptable.

Protective coating shall consist of coal tar primer, coal tar enamel coating, glass fiber, tissue inner wrap followed by glass fiber or coal tar impregnated Kraft outer wrap or finish coat.
Number of coats and wraps, minimum thickness for each layer of application shall be as per IS-10221. Number of. Coats and wraps shall be decided based on soil corrosivity/resistivity as indicated in IS-10221. Soil data-for this purpose shall be made available.

Total thickness of completed coating and wrapping shall not be less than 4.0 mm.

b. Alternatively, the anti-corrosive protection for buried pipes can consist of anti-corrosive protection Coal-tar tapes. Material and application of tapes shall conform to IS 15337 or equivalent. These-tapes shall be applied hot over the cold coal tar

primer in steps of 2mm thickness so as to cover the spiral edges of the first tape by the application of second tape. The total thickness of the finished protective coating shall be 4.0 mm minimum.

2.09.04 **Trench bed preparation and back filling**

Prior to lowering and laying pipe in any excavated trench, the bottom of the trench may require to be back filled and compacted (or as the case may be) to provide an acceptable bed for placing the pipe. Bed preparation in general shall be as per IS: 5822.

2.09.05 **laying of galvanized steel (GI) pipes**

All the joints shall be screwed with socket or flanged. Screwed ends of GI pipes shall be thoroughly cleaned and painted with a mixture of red and white lead before jointing Threaded portion on either side of the socket joint shall be applied with Zinc silicate paste.

All the provisions for trenching' bed preparation' laying the pipe application of primer' coating' wrapping with tapes and back filling etc. as indicated for "laying of buried piping" and " anti corrosive protection for buried piping" are applicable for buried galvanized steel (GI) pipes also.

2.10.00 **Cleaning and flushing**

2.10.01 All piping shall be cleaned by the Bidder before and after erection to remove grease, dirt, dust, scale and welding slag.

2.10.02 Before erection all pipe work, assemblies, sub-assemblies, fittings, and components, etc. shall be thoroughly cleaned internally and externally by blast cleaning or by power driven wire brushes and followed by air-blowing . However for pipe sizes below 100nb the pipes may be cleaned internally by compressed air blowing as an alternative to internal blast cleaning. The brushes shall be of the same or similar material as the metal being cleaned. Cleaning of Galvanized pipes shall be done by air blowing only.

2.10.03 After erection, all water lines shall be mass flushed with water. The cleaning velocities in water lines shall be 1.2-1.5 times the operating velocities in the pipelines.

2.10.04 All compressed air pipe work shall be cleaned by blowing compressed air.

2.11.00 **Specification for hangers and supports**

2.11.01 All supports and parts shall conform to the requirement of power piping code ANSI B 31.1 or approved equivalent.

2.11.02 The maximum spans of the supports of straight length shall not exceed the recommended values indicated in ANSI B 31.1.

2.11.03 At all sliding surfaces of supports suitable arrangement is to be provided to minimize sliding friction.

2.12.00 **Design/Construction/Material Particulars of Gate/ Globe /Check /Butterfly / Ball / Air release /Float valves / Moisture Traps.**

2.12.01 **GENERAL**

(a) All valves shall have indicators or direction clearly marked on the hand-wheel so that the valves opening/closing can be readily determined.

(b) Special attention shall be given to operating mechanism for large size valves with a view to obtaining quick and easy operation ensuring that a minimum of maintenance is required.

(c) The valves coming in vacuum lines shall be of extended gland type and/or water sealed.

(d) The actuator-operated valves shall be designed on the basis of the following:

(1) The internal parts shall be suitable to support the pressure caused by the actuators;

(2) The valve-actuator unit shall be suitably stiff so as not to cause vibrations, misalignments, etc.

(3) All actuator-operated valves shall be provided with hand operated gearing mechanism also.

(4) All actuators operated valves shall open/ close fully within time required by the process.

(e) Valves coming under the purview of IBR shall meet IBR requirements.

(f) All valves shall be provided with embossed name plate giving details such as tag number, type, size etc.

(g) Wherever required valves shall be provided with chain operator, extension spindles and floor stands or any other arrangement approved by employer so that they can be operated with ease from the nearest operating floor. Wherever necessary for safety purpose locking device shall be provided. Further, necessary small platforms for facilitating easy valve operation shall be provided by the contractor wherever necessary in consultation with project manager within the bid price at no extra cost to employer

2.12.02 **VALVE BODY MATERIAL**

Valve body material for various services shall be as follows:

Valve body material for water application like Secondary circuit auxiliary cooling water of ECW system, Raw water, Ash water make-up, service water, clarified water, DM cooling water (pH corrected) , drinking water etc. shall be cast iron for sizes 65NB and above; gun-metal for sizes 50 Nb and below.

For compressed air application, valve body material shall be cast carbon steel or forged carbon steel for sizes 65 mm NB & above and Gun metal for sizes 50 NB and below.

DM water: SS body and disc along with SS internals. However for butterfly valves, Cast Iron /Ductile Iron/SG iron/carbon steel body and disc with elastomer lining are also acceptable.

Condensate: Cast Carbon Steel / Forged Carbon Steel.

2.12.03 The design, material, construction, manufacture, inspection, testing and performance of valves shall comply with all currently applicable statutes, regulations and safety codes in the locality where the valves will be installed. The valves shall conform to the latest editions of applicable codes and standards as mentioned elsewhere. Nothing in this specification shall be construed to relieve the Bidder of his responsibility. Valves in general shall conform to the requirements of the following standards.

Standards and Codes

AWWA-C-504	Rubber seated butterfly valves.
BS-5155/EN-593	Cast iron and steel body butterfly valves for general purpose.
IS-778	Gun-metal gate, globe and check valves for general purpose.
BS-5154	Copper alloy globe/globe stop and check and gate valves for general purpose.
IS-780	Sluice valves for water works purpose (50-300 mm size)
IS-2906	Sluice valves for water works purpose (350-1200 mm size)
IS-5150	Cast iron wedge and double disc gate for general purpose.
BS-5152	Specification for cast iron globe valves.
BS-5153	Cast iron check valves for general purpose.
IS-5312	Swing check type reflux (non-return) valves.
ANSI B 16.34	Standard for valves.
API-594	Standard for Dual-check valves.
API-600	Steel gate valves.
ANSI-B-16.10	Valves face to face and other relevant dimension.
API-598	Valves inspection test.

2.12.04 **End Connections**

The end connections, shall comply with the following:

Socket welding (SW) - ANSI B 16.11

Butt Welding (BW) - ANSI B 16.25.

Threaded (SC) - ANSI B 2.1

Flanged (FL) - ANSI B 16.5& AWWA-C-207 (steel flanges), ANSI B 16.1 (Cast Iron flanges).

2.13.00 **Gate/Globe/Check Valves**

(a) All cast iron body valves (gate, globe and non-return) shall have flanged end connections; (screwed ends for Ductile D.2NI body valves are not acceptable).

(b) All steel and stainless steel body valves of sizes 65 mm and above shall have flanged or butt welding ends. Valves of sizes below 65mm shall have flanged or socket welded ends. Compatibility of welding between valve body material and connecting pipe material is a pre-requisite in case of butt-welded joints.

(c) All gun metal body valves shall have screwed ends.

(d) All flanged end valves/specialties. shall be furnished along with matching counter flanges, fasteners, gaskets etc. as required to complete the joints.

(e) Gate/sluice valves shall be used for isolation of flow. All gate valves shall be of the full-way type, and when in the full open position the bore of the valve shall not be constricted by any part of the gate.

Gate valves shall be of the solid/elastic or articulated wedge disc. Gate valves shall be provided with the following accessories in addition to other standard items:

(1) Hand wheel

(2) Position indicator (for above 50 mm NB valve size)

(3) Draining arrangement wherever required.

(f) Globe valves shall be used for regulation purposes. They shall be provided with hand wheel, position indicator, draining arrangement (wherever required) and arrow indicating flow direction. Preferably, the valves shall be of the vertical stem type. Globe valves shall preferably have radiused or spherical seating and discs shall be free to revolve on the spindle.

The pressure shall preferably be under the disc of the valve. However, globe valves, with pressure over the disc shall also be accepted provided (i) no possibility exists that flow from above the disc can remove either the disc from stem or component from disc (ii) manual globe valves can easily be operated by hand. If the fluid load on the top of the disc is higher than 40-60 KN, bypass valve shall be provided which permits the downstream system to be pressurized before the globe valve is opened.

(g) Check valves shall be used for non-return service. They shall be swing. check type or double door (Dual plate)check type with a permanent arrow inscription on the valve body indicating the fluid flow direction. In long distance pipes lines with possibility of surge-occurrence, dual plate check valves are preferable for its spring controlled opening /closing of flaps/doors against flow reversals. However, dual plate check valves shall not be used for sizes more than 600mm NB.

(h) For bore greater than 2" the valves must be swing check type or dual plate check type suitable for installation in all positions (vertical and horizontal);

(i) For bore smaller than or equal to 2" the valves must be of the piston type to be installed, in horizontal position.

(j) All gate and globe valves shall be provided with back seating arrangement to enable on line changing of gland packing. The valves shall be preferably outside screw & yoke type.

(k) All gate and globe valves shall be rising stem type and shall have limit switches for full OPEN and full CLOSED indication wherever required. This will include motor-operated valves also wherever required. In such cases the limit switches shall form an integral part of the valve. Stop-gap arrangement in this respect is not acceptable.

(l) All valves except those with rising stems shall be provided with continuous mechanical position indicators; rising stem valves shall have only visual indication through plastic/metallic stem cover for sizes above 50 mm nominal bore.

(m) For CI gate, globe and check valves wherever thickness of body/bonnet is not mentioned in the valves standards, thickness mentioned in IS- 1538 for fitting shall be applicable.

2.13.01 **MATERIAL OF CONSTRUCTION (GATE/GLOBE/CHECK VALVE)**

(a) The materials shall generally comply with the following:

(1) **Cast Steel Valves**

Body & bonnet	ASTM A 216 Gr. WCB/ ASTM A 105
Disc for non-return Valves	ASTM A 216 Gr. WCB/ ASTM A 105
Trim.	ASTM A 182 Gr. F6 or Equivalent

(2) **Stainless steel valves**

Body & Bonnet	SS 304
Disc	-do-
Trim.	SS 316

(3) **Cast iron valves**

Body & bonnet	BS 1452 Gr. 14/ IS-210 Gr. FG 260
Seating surfaces and rings	13% chromium steel/ 13% Chrome overlay
Disc for non-return valves	BS 1452 Gr. 14/IS-210 Gr FG 260
Hinge pin for non-return valves	AISI 316
Stem for gate globe valves	13% chromium steel or Equivalent
Back seat	13 % chromium steel / 13% Chrome overlay

(4) **Gun Metal valves**

Body and bonnet	IS 318 Gr. 2/ Equivalent Standard
Trim.	-do-

(b) Cast iron body valves shall have high alloy steel stem and seat.

(c) Material for counter flanges shall be the same as for the piping.

(d) Forged carbon steel valves are also acceptable in place of Gun metal valves.

2.14.00 **Air Release Valve**

(a) The air release valves shall be of automatic double air valve with two orifices and two floats. The float shall not close the valve at higher air velocities. The orifice contact joint with the float shall be leak tight joint.

(b) The valve shall efficiently discharge the displaced air automatically from ducts/pipes while filling them and admit air automatically into the ducts/pipes while they are being emptied. The valve shall also automatically release trapped air from ducts/pipes during operation at the normal working pressure.

(c) Body material of automatic air release valves shall comply generally with BS 1452 Gr. 14/IS: 210 Gr. FG 260. and spindle shall conform to high tensile brass.

(d) Air release valves shall not have any integral isolation device within them. Each Air release valve shall be mounted, preceded by a separate isolation gate/ butterfly valve.

2.15.00 **Butterfly valves**

2.15.01 **Design/Construction**

(a) The valves shall be designed for the design pressure/temperature of the system on which it is installed and in accordance with AWWA-C-504, EN-593 or any other approved equivalent standard latest edition. Fabricated steel (IS: 2062 GR. E-250B) butterfly valves instead of cast iron body valves are also acceptable for size above 300 mm nb diameter.

(b) The valves shall be suitable for installation in any position (horizontal/vertical etc.) and shall be generally of double-flanged construction. However for sizes 600 NB and below the valves of Wafer construction are also acceptable

(c) Valves-350Nb and above shall have pressure equalizing bypass valves, wherever system parameters warrant the same.

(d) Valves-200Nb and above shall also be provided with gear operator arrangement as a standard practice suitable for manual operation. Manual operation of valve shall be through gear arrangement having totally enclosed gearing with hand wheel diameter and gear ratio designed to meet the required operating torque It shall be designed to hold the valve disc in intermediate position between full open and full closed position without creeping or fluttering. Adjustable stops shall be provided to prevent over travel in either direction.

Limit and torque switches (if applicable) shall be enclosed in water tight enclosures along with suitable space heaters for motor actuated valves, which may be either for On-Off operation or inching operation with position transmitter.

2.15.02 **Material of Construction (Butterfly Valves)**

Materials and other design details shall be as indicated below :

(a) **Cast Iron Butterfly Valves**

Body & Disc	ASTM A48, Gr. 40 with 2% Ni / IS: 210. Gr. FG-260, with 2% Ni / SG iron BSEN 1563, Gr EN GJS-400-15 with 2%Ni and epoxy coated

	Shaft	BS 970 431 S: 291 / EN 57, or AISI-410 or AWWA-permitted shaft material equivalent to EN-57/AISI-410 or better.
	Seat ring	18-8 Stainless steel
	SEAL	NITRILE RUBBER

(b) **Stainless Steel Butterfly Valves**

Body & Disc	SS 304
Shaft	SS 316
Seat Rings	EPT/BUNA-N/Neoprene

(c) **Carbon steel Butterfly Valves**

Body & Disc	ASTM A 216, Gr. WCB
Shaft	SS 304
Disc & Seat Rings	EPT/BUNA-N/Neoprene

(d) **Elstomer lined Butterfly Valves**

Body & Disc	ASTM A48, Gr. 40 / IS: 210. Gr. FG-260 / SG Iron (ductile iron) IS 1865 Gr 400-15 or BSEN 1563, Gr EN GJS-400-15 / ASTM A 216, Gr. WCB with elastomer lining.
Shaft	SS 316

2.15.03 **Proof of Design Test (Type Test) for Butterfly Valves**

Proof of Design (P.O.D.) test certificates shall be furnished by the bidder for all applicable size-ranges and classes of Butterfly valves supplied by him, in the absence of which actual P.O.D. test shall be conducted by the bidder.

All valves that are designed and manufactured as per AWWA-C-504 / AWWA-C-516 shall be governed by the relevant clauses of P.O.D test in AWWA-C-504/AWWA-C-516. For Butterfly valves, designed and manufactured to EN-593 or equivalent, the P.O.D. test methods and procedures shall generally follow the guidelines of AWWA-C-504 in all respect except that Body & seat hydro test and disc-strength test shall be conducted at the pressures specified in EN-593 or the applicable code. Actuators shall also meet requirements of P.O.D. test of AWWA-C-504/AWWA-C-516.

2.16.00 **Float operated valves**

(a) Valve shall automatically control the rate of filling and will shut off when a predetermined level is reached and close to prevent over flow on pre-set maximum water level. Valve shall also open and close in direct proportion to rise or fall of water level.

(b) DESIGN AND CONSTRUCTION FEATURES

The following design and construction feature of the valve shall be the minimum acceptable.

(c) Valves shall be right-angled or globe pattern.

(d) Valves shall be balance piston type with float ball.

(e) Leather liner shall not be provided.

(f) The body and cover material shall be cast iron conforming to ASTM-A 126 Grade 'B' or IS: 210 Grade 200 or equivalent, and Float shall be of copper with epoxy painting of two (2) coats.

(g) Valves shall be suitable for flow velocities of 2 to 2.5m/sec.

(h) The valves shall have flanged connections.

2.17.00 **Tanks and Accessories**

2.17.01 The designer and manufacturer of storage tanks shall comply with and obtain approval of all currently applicable statutory regulations and safety codes in the locality where the equipment will be installed. The tanks shall conform to IS 803/IS804/IS 805/ IS 2825/ API 650/ IS 4049/ IS 4682 (part-I) and IS 4864 to 4870/ ASME B & PV code Sec.-VIII as the case may be.

2.17.02 **DESIGN AND CONSTRUCTION**

(a) Design of all vertical atmospheric storage tanks containing water, acid, alkali and other chemical shall conform to IS:803 & API 650.

(b) Design of all horizontal atmospheric storage tanks containing water, acid, alkali and other chemicals shall generally conform to IS:2825 as regards to fabrication and general construction taking care of combined bending, shear & hoop stresses developed due to supporting arrangement.

(c) Tank shall be made from mild steel plates to BS 4360/IS-2062 Gr.E-250B (or equivalent) for ordinary wafer application when it is not corrosive in nature.

(f) Tank shall be provided with suitable supporting joints. All vessels shall be provided with lifting lugs, eye bolts etc. for effective handling during erection.

(j) Tanks shall be provided with float operated level indicators/level gauges/level transmitters and level switches, as required, with complete assembly. Suitable flanged pads for level switches mounting shall also be provided. The level indicator can be top or side mounted as the case may be.

(k) In addition to inlet and outlet nozzles, the tanks shall be provided with vents, overflow, drain nozzles complete for various connections on tanks. Overflow lines from storage tanks is to be routed to the nearest surface drains. For tanks containing dm water, alkaline water or power cycle water the vent to atmosphere shall be through carbon-di-oxide absorber vessel suitably mounted on the tank. CO_2 absorber vessel shall be provided with the initial fill of chemicals.

(l) Tanks shall have suitable stairs/ladders on inside and outside of the tanks, manholes/inspection covers as required and also platform suitably located.

(m) Tank supporting arrangement as approved by Employer shall be provided with all plates/angles/joints/flats and supporting attachment including lugs, saddles, legs etc.

(o) Tank fabrication drg. and design calculations shall be approved by the Project Manager.

2.17.03 **Corrosion protection**

(a) A corrosion allowance, applicable to surface in contact with corrosive media, when required after thorough cleaning by blast cleaning preceded by wire brushing shall be taken into consideration.

(b) Manholes shall be provided for easy access into the vessels. The size shall be minimum 500 mm and will be with cover plate, nuts bolts, etc. to ensure leak tightness at the test pressure.

(c) Each tank shall be provided with drilled cleats welded to the tank for electrical grounding. Material of cleats shall be same as that of the shell.

Sl. No.	Description	Tech. Particulars
1.00	**CONDENSATE STORAGE TANKS**	
1.01	Number required	one for each unit
1.02	Capacity of each tank (Effective)	450 Cu.m (for 800MW units),
1.03	Size (Dia & Height)/Plate Thickness	9mx8.2m minimum), Shell & Roof plate Thickness 8mm and Base plate thickness 10mm
1.04	Type and pressure class	Vertical, cylindrical, atmospheric
1.05	Material of construction	MS- (IS-2062 Gr.B or equivalent) as per specified code, 8mm thickness (minimum)
1.06	Location	Outdoor
1.07	Overflow, drain, vent and Sample connection(piping &valve)	required
1.08	Level Indicator	
	a) Number	One for each tank
	b) Type	Mechanical float type with dial type indicator (Guide wire, Float and Housing of Stainless steel - 316 Gr. construction)

	1.09	Manhole (minimum 500mm size)	Two (2)-one on shell and the other on roof
	1.10	Special Fittings	
		a) Hydraulic Seal of Overflow/Drain	Required
		b) Additional nozzle Connection	number and size to be indicated to successful Bidder
		c) Nozzle connection for Instrument/spare	Three (3) nos. for each tank
		d) CO2 Absorber for vent (not to be kept on roof of tank, but to be kept on ground level)	required
		e) Outside stair case (spiral)	required
		f) Inside Ladder	Required
		g) Draw off sump	required
		h) Root valve for level Transmitter	Root valves for two (2) nos. level transmitter for each tank Required

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2.18.00 **RUBBER EXPANSION JOINTS**

2.18.01 All parts of expansion joints shall be suitably designed for all stresses that may occur during continuous operation and for any additional stresses that may occur during installation and also during transient condition.

2.18.02 The expansion joints shall be single bellow rubber expansion joints. The arches of the expansion joints shall be filled with soft rubber.

2.18.03 The tube (i.e. inner cover) and the cover (outer) shall be made of natural or synthetic rubber of adequate hardness. The shore hardness shall not be less than 60 deg. A for outer and 50 deg. A for inner cover.

2.18.04 The carcass between the tube and the cover shall be made of high quality cotton duck, preferably, square woven to provide equal strength in both directions of the weave. The fabric plies shall be impregnated with age resistant rubber or synthetic compound and laminated into a unit.

2.18.05 Reinforcement, consisting of solid metal rings embedded in carcass shall be provided.

2.18.06 Expansion joints shall be complete with stretcher bolt assembly. The expansion joints shall be suitable to absorb piping movements and accommodate mismatch between pipe lines.

2.18.07 The expansion joints shall be of heavy duty construction made of high grade abrasion-resistant natural or synthetic rubber compound. The basic fabric for the' duck' shall be either

a superior quality braided cotton or synthetic fibre having maximum flexibility and non-set characteristic.

2.18.08 The expansion joints shall be adequately reinforced, with solid steel rings, to meet the service conditions under which they are to operate.

2.18.09 All expansion joints shall be provided with stainless steel retaining rings for DM water application and IS 2062 Gr E-250B galvanized steel retaining rings for ordinary water for use on the inner face of the rubber flanges, to prevent any possibility of damage to the rubber when the bolts are tightened. These rings shall be split and beveled type for easy installation and replacement and shall be drilled to match the drilling on the end rubber flanges and shall be in two or more pieces.

2.18.10 The expansion joints shall have integral fabric reinforced full-face rubber flanges. The bolt on one flange shall have no eccentricity in relation to the corresponding bolt hole on the flange on the other face. The end rubber flanges shall be drilled to suit the companion pipe flanges. The flanges shall be as per ANSI B 16.5. For higher sizes, not covered under ANSI B 16.5, the same shall be as per AWWA.

2.18.11 All exposed surfaces of the expansion joint shall be given a 3 mm thick coating of neoprene. This surface shall be reasonably uniform and free from any blisters, porosity and other surface defects.

2.18.12 Each control unit shall consist of two (2) numbers of triangular stretcher bolt plates, a stretcher bolt with washers, nuts, and lock nuts. Each plate shall be drilled with three holes, two for fixing the plate on to the companion steel flange and the third for fixing the stretcher bolt.

2.18.13 Each joint shall have a permanently attached brass or stainless steel metal tag indicating the tag numbers and other salient design features.

2.18.14 Bidder to note that any metallic part which comes in contact with DM /corrosive water shall be of Stainless Steel material.

2.19.00 **STRAINERS**

2.19.01 **Simplex type**

The strainers shall be basket type and of simplex construction. The strainer shall be provided with plugged drain/blow off and vent connections. The free area of the strainer element shall be at least four (4) times the internal area of the connecting pipe lines. The strainer element shall be 20 mesh. Pressure drop across the strainers in new condition shall not exceed 1.5 MCW at full flow. Wire mesh of the strainers shall be suitably reinforced, to avoid buckling under operation. Strainer shall have screwed blow off connection fitted with a removable plug. The material of construction of various parts shall be as follows:

(a)	Body	IS: 318, Gr. 2 up to 50 mm Nb, and IS: 210 Gr. FG 260 above 50 mm Nb. (For DM water/ -Body: AISI 316 or equivalent)
(b)	Strainer Element	Stainless steel (AISI 316)
(c)	End connection	Screwed upto 50 mm Nb, and Flanged above 50 mm Nb

2.19.02

Duplex type

(a) The strainers shall be basket type and of duplex construction. The strainer shall be provided with plugged drain/blow off and vent connections. The free area of the strainer element shall be at least four (4) times the internal area of the connecting pipe. The mesh of strainer element shall be commensurate with the actual service required. Pressure drop across the strainer in new condition shall not exceed 4.0 MWC at full flow.

(b) Wire mesh (if applicable) of the strainers shall be suitably reinforced. The material of construction of various parts shall be as follows.

Body	IS: 318, Gr. 2 up to 50 mm Nb, and IS:210, Gr. FG 260 or ASTM-A-515 Gr. 75/IS-2062 Gr. E-250B and internally epoxy-painted above 50 mm NB.
Strainer element	Stainless steel (AISI 316)
End connection	Screwed up to 50mm Nb, and Flanged above 50 mm Nb. Gasket shall be of full face type

(c) The strainer will have a permanent stainless steel tag fixed on the strainer body indicating the strainer tag number and service and other salient data.

(d) The size of the strainer and the flow direction will be indicated on the strainer body casting.

(e) Thickness of the strainer element should be designed to withstand the pressure developed within the strainer due to 100% clogged condition exerting shut-off pressure on the element.

SUB – SECTION – A-11

MAKE-UP WATER PIPING

SPECIFICATION FOR PIPES (MAKE UP WATER SYSTEM)

MS Pipes

1.00.00 GENERAL

This specification covers the specific requirement of design, material, manufacture/ fabrication, constructional features, inspection & testing, supply and delivery of spiral welded carbon steel pipes.

1.01.00 CODE AND STANDARDS

The design, manufacture, inspection and testing of MS water pipes shall comply with the latest BIS Standard (Indian Standard). IS: 3589 (Steel Pipes for Water and Sewage (168.3 to 2540 mm Outside Diameter)) or Equivalent ASTM / API / DIN or any other International Standard unless otherwise specified elsewhere in this Technical Specification.

The equivalency of design standard proposed to be adopted by the Bidder/ Supplier with the specified Indian Standard (IS: 3589) shall be clearly brought out in the Bid by comparing the various parameters, process description etc.

1.02.00 DESIGN & MANUFACTURING REQUIREMENTS

1.02.01 The pipe shall conform to designation Spirally weld (SAW) Fe410 of IS: 3589 or Equivalent Standard.

1.02.02 The pipe shall be manufactured by Submerged Arc welded process with Spiral seam welding as per IS: 3589 or Equivalent standard.

1.02.03 The dimensional details & acceptable tolerances of the required pipes be as follows:

a) Bidder shall decide the pipe diameter considering the techno economics and corresponding thickness conforming to IS: 3589 or Equivalent design standard.

b) Tolerance on outside diameter and thickness shall conform to IS: 3589 or Equivalent design standard.

c) Random length of pipe to be supplied shall be 12 meters plus or minus 2 meters. (i.e.) 10 to14 M length.

d) Tolerance on Straightness of pipe shall not be more than 0.2 percent of length of each pipe.

e) The ovality shall not exceed 1% of the nominal diameter of the cross section under consideration subject to a maximum of 10 mm.

1.02.04 Both the ends of each pipe length of pipe shall be manufactured with bevel ends and shall be delivered with end protection covers.

1.02.05 They should be truly cylindrical of clear internal diameter specified, of uniform thickness, smooth and strong, free from dents, cracks and holes and other defects.

1.02.06	All materials shall be new and procured directly from the manufacturers for this projects.
1.02.07	All the pipes shall be applied with a protective coat of red oxide primer or varnish externally to prevent rusting during the period of transportation & storage before the pipes are used for installation.
1.03.00	**INSPECTION AND TESTING**
1.03.01	All Material shall be tested as per relevant design standard.
1.03.02	All the mechanical and chemical tests including optional tests if any as per the relevant standards shall be carried out and the test certificates for the same shall be submitted for Employer's approval.
1.03.03	The hydraulic tests shall be conducted as per the piping standard (i.e.) IS: 3589 or Equivalent Standard.
1.03.04	Prior to testing, the pipe shall be inspected thoroughly and all the apparent defects in welding such as porosity etc. shall be repaired by gouge and re-welding.
1.04.00	**TRANSPORTATION AND DELIVERY OF PIPES**
1.04.01	All pipes fabricated in the factory and temporarily stacked in the Contractor's yard or factory shall be transported to the Employer's storage site after shop testing & cleaning them internally. The loading in the factory shall be carried out by means of either a crane, gantry or with shear legs, so as not to cause any damage to the finished material. Similarly, while unloading and stacking, great care shall be taken to ensure that the material is not damaged or dented. The equipments to be used for loading / unloading shall be as approved by the Employer or his representative.
1.04.02	The material being delivered at site shall be jointly inspected by the Employer or his representative and the Contractor and defective or damaged pipe shall be rejected by Employer or Employer may allow repair of the pipe to the satisfaction of the Employer or his Representative.
1.04.03	Props of approved designs shall be fixed to the pipes during transit to avoid undue sagging and consequent distortion. After the pipes are carefully stacked, props may be removed and re-used for subsequent operations.
1.04.04	At Employer's storage site, pipes shall be stacked in such a way that suitable gaps shall be left in the pipes at intervals to permit access from one side to the other.
1.04.05	For Tech Specification details not covered in this chapter, bidder to refer sub section A-08A (chapter- Low pressure piping).

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GENERAL TECHNICAL REQUIREMENT OF PUMPS

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HORI□ONTAL CENTRIFUGAL PUMPS

1.00.00 SCOPE

General requirements in respect of design, material, constructional features, manufacture, inspection, testing the performance at the Vendor's/ Sub-Vendor's works and delivery to site erection, field testing and commissioning of Horizontal Centrifugal Pumps.

2.00.00 CODES AND STANDARDS

2.01.00 Design, material, construction manufacture inspection and performance testing of Horizontal Centrifugal Pumps shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. The equipment supplied shall comply with the latest applicable Indian standards listed below. Other National Standards are acceptable, if they are established to be equal or superior to the Indian Standards.

2.02.00 **L□□□□A□□□□□□□ S□□□d□rd□**

i) IS : 1520 - Horizontal Centrifugal Pumps for clear cold fresh water.

ii) IS : 5120 - Technical requirements of roto-dynamic special purpose pumps

iii) API - 610 - Centrifugal pumps for general refinery service.

iv) IS : 5639 - Pumps Handling Chemicals & corrosion liquids.

v) IS : 5659 - Pumps for process water

vi) HIS - Hydraulic Institute Standards; USA

vii) ASTM-I-165-65 - Standards Methods for Liquid Penetration Inspection.

2.03.00 In case of any contradiction with aforesaid standards and the stipulations as per the technical specifications as specified hereinafter the stipulations of the technical specifications shall prevail.

3.00.00 DESIGN RE□UIREMENTS

3.01.00 The maximum efficiency of pumps shall be preferably within + 10% of the rated design flow indicated in data sheets.

3.02.00 Total head capacity curve shall be continuously rising from the operating point towards shut - off without any zone of instability and with a minimum shut off head of 15% more than design head.

3.03.00 Pumps of a particular category shall be identical and shall be suitable for parallel operation with equal load division. The head Vs capacity and BHP Vs capacity characteristics should match to ensure even load sharing and trouble free operation throughout the range. Components of identical pumps shall be interchangeable.

3.04.00 Pumps shall run smoothly without undue noise and vibration. Peak to peak vibration limits shall be restricted to the following values during operation.

	S□□□d	**A□□□r□□□□□ □□□r□□□**	**S□□□□□ □□□r□□□**
	1500 rpm and below	75.0 micron	75.0 micron
	3000 rpm	50.0 micron	65.0 micron

The noise level shall not exceed 85 dBA. Overall sound pressure level reference 0.0002 microbar (the standard pressure reference for air sound measurement) at a distance of 1M from the equipment surface.

3.05.00 The pumps shall be capable of starting with discharge valve fully open and close condition.

4.00.00 DESIGN CONSTRUCTION

4.02.00 Pump casing shall have radially/axially split type construction. The casing shall be designed to withstand the maximum shut - off pressure developed by the pump at the pumping temperature.

4.03.00 Pump casing shall be provided with a vent connection and piping with fittings & valves Casing drain as required shall be provided complete with drain valves, piping and plugs. It shall be provided with a connection for suction and discharge pr. Gauge as standard feature.

4.04.00 **I□ □□□□r**

Impeller shall be closed or semi-closed as specified elsewhere and designed in conformance with the detailed analysis of the liquid being handled. The impeller shall be secured to the shaft, and shall be retained against circumferential movement by keying pinning or lock rings.

4.05.00 **I□ □□□□r/ C□□□□□ W□□r□□□ R□□□□**

Replaceable type wearing rings shall be provided at suitable locations pumps. Suitable method of locking the wearing ring shall be used.

4.06.00 **S□□□□**

The critical speed shall be well away from the operating speed and in no case less than 130% of the rated speed.

4.07.00 **S□□□□S□□□□□□**

Shaft sleeves shall be fastened to the shaft to prevent any leakage or loosening shaft and shaft sleeve assembly should ensure concentric rotation.

4.08.00 **B□□r□□□□**

Heavy duty bearings, adequately designed for the type of service specified in the enclosed pump data sheet and for long, trouble - free operation shall be furnished.

The bearings offered shall be capable of taking both the radial and axial thrust coming into play during operation. In case, sleeve bearings are offered additional thrust bearings shall be provided. Anti-friction bearings of standard type, if provided, shall be selected for a minimum life 16,000 hours of continuous operation at maximum axial and a radial loads and rated speed.

Proper lubricating arrangement for the bearings shall be provided such that lubricating element does not contaminate the liquid pumped. Where there is a possibility of liquid entering the bearings suitable arrangement in the form of deflectors or any other suitable arrangement must be provided ahead of bearing assembly.

Bearings shall be easily accessible without disturbing the pump assembly. A drain plug shall be provided at the bottom of each bearing housing.

4.09.00 **Stuffing Box**

Stuffing boxes of packed ring construction type shall be provided wherever specified. Packed ring stuffing boxes shall be properly lubricated and sealed as per service requirements and manufacturer's standard. If external gland sealing is required, it shall be done from the pump discharge. The Bidder shall provide the necessary piping, valves, fitting etc. for the sealing connection.

4.10.00 **Mechanical Seal:**

Wherever specified in pump data sheet, mechanical seals shall be provided The sealing face should be highly lapped surfaces of material known for their low frictional co-efficient & resistance to corrosion against the liquid being pumped.

4.11.00 **Pump & Motor Shaft Coupling**

The Pump and motor shaft shall be connected with a adequately sized flexible coupling of proven design with a spacer to facilitate dismantling of the pump without disturbing the motor.

4.12.00 **Base Plate**

A common base plate mounting both for the pump and motor shall be furnished. The base plate shall be of fabricated steel and of rigid construction, suitable ribbed and reinforced.

4.13.00 **Assembly and Dismantling**

Assembly and dismantling of each pump with drive motor shall be possible without disturbing the grouting base plate or alignment.

4.14.00 **Drive Motor (Prime Mover)**

The KW rating of the drive shall be based on continuously driving the connected equipment for the conditions specified. In case, where parallel operation of the pumps is specified, the actual motor rating is to be selected considering overloading of the pump in the event of tripping of operating pumps. Continuous motor rating (at 50 deg. Cent, ambient) for pump shall be at least 10% above the maximum load demand of the driven equipment in the complete range.

A□□□x□r□-2 □□ □A□x□□□r□W□□□r S□□□□□ "

VERTICAL PUMPS

1.00.00 SCOPE

1.01.00 This specification covers general requirements in respect of design, construction features, manufacture, inspection and performance at Vendor's / sub-vendor's works delivery to site, erection field testing and commissioning of Makeup Water & Raw Water Pumps.

2.00.00 CODES AND STANDARDS

2.01.00 The design, material, construction, manufacture, inspection, testing and performance of Vertical Pumps shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. The equipment supplied shall comply with the latest applicable Standards listed below. Other national standards are acceptable, if they are established to be equal or superior to the listed standards.

2.02.00 **L□□□□□A□□□□□□□□□ S□□□d□rd□**

IS: 1710 : Vertical Turbine Pumps for clear cold fresh water.

IS: 5120 : Technical requirement of rotor dynamic special purpose pumps.

HIS : Hydraulic Institute Standards U.S.A.

PTC 82 : Centrifugal pumps-power test code

API 610 : Centrifugal pumps for general refinery purposes.

In case of any contradiction with aforesaid standards and the specifications requirements as specified hereinafter the stipulations of the technical specifications shall prevail.

3.00.00 DESIGN AND PERFORMANCE RE□UIREMENTS

3.01.00 The maximum efficiency point of the pumps shall preferably lie within 10% of the rated design flow.

3.02.00 Pumps of a particular category shall be identical, suitable for parallel operation and provided with interchangeable components. Head vs. capacity and BHP vs. Capacity characteristic should match to ensure even load sharing and trouble free operation throughout the range.

3.03.00 The pumps shall have stable Head vs. Capacity characteristic continuously rising towards shut-off with the highest at shut-off and with an approximate shut-off head of 15% or more than the design head for radial flow pumps and 50% more than the design head for mixed flow/ turbine type pumps.

3.04.00 The operating range of operation of pumps shall generally be 40% to 120% of rated flow for sustained period of operation.

3.05.00	The power requirement of the pump shall be non-over loading type for mixed flow/ turbine type pumps.
3.06.00	The critical speed of the pump shall be less than 80% of the rated speed or more than 130% of the rated speed. Also, the critical speed of the pump-motor assembly shall be more than the maximum reverse run-away speed.
3.07.00	Pump shall run smoothly without undue noise and vibration. The vibration limit measured at motor end shall not exceed the limit specified in Hydraulic Institute Standards. The noise level shall not exceed 85 dBA overall sound pressure level reference 0.0002 microbar (the standard pressure reference for air sound measurement) at a distance of 1M from the equipment surface.
3.08.00	The base plate, foundation bolts, motor stool and other components shall be designed to take the full force coming on the discharge elbow under shut-off condition due to provision of expansion joint (untied condition prevailing)) on the discharge pipe.
3.09.00	Water for motor cooling and thrust bearing cooling, if required, shall be tapped from the discharge of the pumps and/or fed from an over-head tank. All piping, valves, strainer, instruments etc. required for this purpose and line shaft bearing lubrication (if required) shall be provided by the Contractor. Hence the coolers shall be designed to operate satisfactorily with the cooling water discharge pressure available. Cooling water if required during starting of the pumps shall be arranged by the bidder by provision of water supply tank, valves piping etc.
3.12.00	**R□□□r□□ R□□□□□□**
	a) The pump shall be provided with an approved mechanical device to protect reverse rotation on loss of drive motor power and failure of discharge valve to close.
	b) It is possible that the pump may rotate in the reverse direction in case the discharge butterfly valve is not fully closed or is passing. Hence to prevent starting of the pump, a reverse rotation detection switch shall be provided to prevent starting of motor while rotating in reverse direction.
3.13.00	**M□□□r R□□□□**
	The pumps shall be capable of starting with discharge valve fully closed as well as fully open conditions. Motors shall be selected to suit to the above requirements. Continuous motor rating (at 50°C ambient) for all pumps shall be at least ten per cent (10%) above the maximum load demand of the driven equipment in the complete operating range (including run out condition) to take care of the system frequency/voltage variation.
	Drive motors shall be connected directly to the line shaft of the pump.
4.00.00	**DESIGN AND CONSTRUCTION**
4.01.00	**P□□ □ T□□□**
	Pumps shall be of vertical shaft, single stage/multi-stage, submerged suction, complete with bowl, column & head assembly and drive assembly. The pump design shall be of pullout/non-pull-out type as specified

4.02.00	**D□□□□r□□ □□□d** The pump discharge shall be of above-floor type/sub- floor type as indicated. In certain cases of pump installation where expansion joint is located immediately at the pump discharge, the pump assembly will be subjected to the unbalanced hydraulic thrust. A thrust pad will be built in with the discharge head for transmitting the hydraulic thrust to external structures such that this hydraulic thrust is not transmitted to the foundation bolts for which they may not be designed.
4.03.00	**C□□□□ □ P□□□** Column pipes shall be flanged and bolted and shall be complete with gaskets, nuts and bolts.
4.04.00	**I□ □□□□r** The impeller shall be closed, or semi-open or open as specified elsewhere.
4.05.00	**W□□r□□□ R□□□□** Replaceable type wearing rings shall be provided for both casing and the impeller. For open impellers replaceable casing liners shall also be provided. The difference in hardness of the casing & impeller wearing rings shall be minimum 50 BHN.
4.06.00	**I□ □□□□r & L□□□ S□□□□** Shaft size selected on the basis of maximum combined shear stress must take into consideration the critical speed as per API - 610.
4.07.00	**P□□ □ & S□□□□B□□r□□□□ - □□□r□□□□□□□**
4.07.01	Adequate number of properly designed bearings shall be furnished. All interconnected piping, valves, instruments and fittings for bearing lubrication shall be provided. The type of lubrication i.e. self water lubrication or forced water lubrication shall be provided.
4.07.02	**S□□□□ □□□r L□□r□□□□□□ S□□□□□** The line shaft bearings shall be lubricated by the water being pumped. The main pump and line shaft bearings which are above minimum water level shall be of 'Thordon' type/equivalent. For other line shaft bearings located below minimum water level, cutless rubber bearings can be used.
4.07.03	**F□r□□d □ □□□r □□□r□□□□□□ □□□□□□** The line shaft shall be provided with shaft enclosing tube to exclude pumped water from shaft and bearings. Lubricating water pumps shall be provided to supply lubricating water for bearings. These lubricating water pumps shall get supply from the overhead water storage tank. This tank shall be fed water from the pump discharge header as indicated in tender drawings. Strainers downstream of each lubrication water pumps shall be provided to ensure clean water for the bearings. The lubrication water pumps shall conform to Specification titled "Horizontal Centrifugal Pumps" Complete instrumentation, piping, valves to ensure reliable operation of lubrication system

shall be provided. During initial filling and normal operation the lubricating water shall be tapped from water filling line/potable/nearest source and fed to overhead tank.

4.08.00 **T□r□□□B□□r□□□□**

Single thrust bearing at motor top or separate thrust bearings at pump and motor shall be provided to take care of hydraulic thrust and weight of the rotating assembly.

Thrust bearing shall be spherical roller type or superior, capable of absorbing axial thrust in both directions of rotation. Water required for cooling of thrust bearing shall be taken from pump discharge, wherever applicable.

The thrust bearing shall be rated for continuous operation with thrust as developed in shut-off condition with clearance between the wearing rings in worn out condition to be at least four (4) times the clearance between the wearing rings in new condition.

4.09.00 **P□□ □ M□□□r S□□□□r□□□B□□□ □□□□□ □□□.**

The pump and motor shall have a common support. The necessary supporting frame, base plates, mounting plates etc. as required shall be supplied under this specification.

4.10.00 **S□□□□□□ B□x**

Gland packing shall be provided at the top of the line shaft. Shaft sleeves shall be provided at the stuffing box. The stuffing box shall be of sufficient depth to provide ample packing. The packing glands shall be split type to facilitate repackaging of the stuffing boxes. The space between motor and the stuffing box shall be sufficient to permit removal of gland packing and insertion of new gland packing without dismantling of pump.

4.11.00 **A□□□□ □□□ □□d D□□□ □□□□□□**

Assembly and dismantling of each pump with drive motor shall be possible without disturbing the grouted base/sole plate or alignment.

5.00.00 **MATERIALS OF CONSTRUCTION**

Materials of construction of the pumps shall not be inferior to those specified in this sub-section.

6.00.00 OPERATION PHILOSOPHY

6.01.00 The Pumps shall be controlled from the Central Control Room (CCR). The start/stop commands of these pumps, all associated auxiliaries/drives including all the motor operated discharge valves, shall be routed through control system where all interlocks & permissive shall be implemented and start/stop signals shall be issued to MCC/Switchgear. The operation of interconnecting valve and any other common drive shall be possible from pump house as well as DDCMIS. The exact details of the same shall be finalised during detailed engineering.

6.02.00 A local pushbutton switch shall be used for emergency tripping of the motor.

6.03.00	The pump can be started either with pump discharge valve partially open or in closed position depending upon contractor's standard practice.
6.04.00	An interlock shall prevent the starting of pump unless bearing lubricating water flow and motor bearing cooling water flow has been established over a period of time. Low flow of either pump or motor bearing cooling water when the pump is running will give alarm(s) and trip the pump with alarm in case of sustained low value over a preset time.
6.05.00	In case of high pressure at pump discharge due to accidental closure of any of the butterfly valves, an alarm shall be generated.
6.06.00	In case of normal stopping, when a pump control switch is turned 'OFF', the butterfly valve at its discharge first closes (25-30) % before the respective pump motor is de-energised.
6.07.00	On tripping of motor due to any reason, the butterfly valve at the discharge shall close fully automatically.
6.08.00	If water level in pump sump is low, an alarm shall be initiated. Pump shall be tripped in case of very low level of water in the intake sumps and very high discharge header pressure. Ultrasonic type Level transmitters to be provided for sump level measurement.
6.09.00	Pump shall be tripped from very high winding temperature of motor and very high metal temperature of thrust bearings. Alarm shall be provided for high motor winding temperature and high motor/ pump bearing temperature.
6.10.00	The operation philosophy as detailed above is suggestive only. .The control and interlock scheme to be adopted shall be finalised in consultation with the successful bidder after award of contract and shall be subject to Employer's approval.
□.00.00	**INSTRUMENTATION**
7.01.00	Vibration monitoring system if necessary shall be provided. The alarm and trip signals from vibration system shall be connected to the Control system.
7.02.00	Bidder shall provide Duplex temperature elements for bearing & winding temperature monitoring points if specified. The excessive bearing/winding temperature shall be used for alarm and tripping of pumps/ motors.
7.03.00	Further, Bidder shall provide required level & pressure sensing instruments as specified elsewhere in relevant Subsections of Control & Instrumentation and/or tender drawings.
8.00.00	**PERFORMANCE TESTS**
	The requirements of Performance Tests of pumps shall be same as that Performance Test specified for the CW Pump of Vertical wet pit type as referred in relevant clauses of Technical Specification.

A□□□x□r□-3 □□ C□□□□□r "AWS S□□□□□ "

SUBMERSIBLE PUMPS

1.00.00 SCOPE

1.01.00 This specification covers general requirements in respect of design, material, manufacture, construction, testing & inspection at Vendor's/sub-vendor's delivery to side, of submersible pumps.

2.00.00 CODES AND STANDARD

The design manufacture and performance of submersible pumps shall comply with all currently applicable statues, regulation, and safely codes in the locality where the Equipment will be installed. The Equipment shall also conform to the latest applicable Indian standards listed below/equivalent standards.

2.01.00 **L□□□□A□□□□□□□ l□d□□ S□□□d□rd□**

IS: 5120- Technical requirement of Rotodynamic Special Purpose pumps.

In case of any contradiction with aforesaid standards and the technical specification requirements, the stipulation of the technical specification shall prevail.

3.00.00 G□□□r□□

3.01.00 The submersible pumps shall be of proven design. The Pumps shall be purchased from a pump manufacturer who has manufactured and supplied at least One (1) no. of submersible pump set for continuous duty for similar application, of type and capacity as offered or higher and which has been in successful operation for at least one (1) year prior to the date of Techno-Commercial bid opening. The pump set shall be suitable for pumping raw water with high turbidity and soft solids/fibrous solids which are generally observed in contaminated rivers / canal water. Components of Identical pumps shall be interchangeable.

3.02.00 Pumps shall have continuously rising head characteristics. The pump sets shall be suitable for parallel operation as well as solo operation in the system. The performance characteristics of the pumps running in parallel shall be identical. The manufacturer shall have to submit the parallel operation curve superimposed with system resistance curve to know the exact point of pump operation with various combinations.

4.00.00 FEATURES OF CONSTRUCTION

a) The pump set shall be single stage, submersible type, monoblock, volute type driven by squirrel cage induction motor. The motor shall be an integral part of the pump set. It shall be a totally sealed unit suitable for completely as well as partially submerged condition. The pump shall operate continuously even if the water level in the sump is low (motor portion not in submerged condition). The pump shall be suitable for reverse rotation and shall not have any adverse effect on the operation of mechanical seal or any other component.

b) Pumps shall be able to pass through solids upto 40 mm.

c) The impeller shall be multi vane. The impeller shall not get blocked with solids. The impeller shall be keyed on shaft, retained with an expansion ring. The impellers shall be dynamically balanced to the grade 6.3 as per ISO 1940.

d) Coupling device when provided shall ensure leak proof joint between the pump and discharge elbow. This shall also enable pump to be removed from the sumps without the necessity of dismantling any nuts, bolts etc.

e) Pumps shall be portable/ fixed type and capable of using in any sump as and when required. Pump shall be provided with required duck foot bend, guide pipe, chain connection etc. for easy installation, removal and maintenance. Adequate length of chain required for lowering the pump into the sump and discharge pipe or duck foot shall be provided.

f) **B□□r□□**:

The shaft shall rotate on grease lubricated bearings. The upper bearing, provided for radial forces, shall be a single roller bearing. The lower bearing shall consist of at least one roller bearing for radial forces and one angular contact ball bearing for axial thrust.

The bearings shall be pre-lubricated and packed for life. External lubrication for any of the bearings will not be accepted.
The lower bearing housing shall include an independent thermal sensor to monitor the bearing temperature. If a high temperature occurs, the sensor shall activate an alarm and shut the pump down.
Any other proven arrangement which is manufacturer's standard is also acceptable.

g) **S□□□□□**:

Each pump shall be provided with a mechanical seal assemblies. The seal faces shall be of corrosion resistant tungsten carbide. The seal shall not require any maintenance or adjustment and shall be bi-directional. Should the seals fail and allow fluid to enter the stator housing, the fluid shall not come in contact with the lower bearing or stator.

h) Shaft:

The pump shaft and motor shaft shall be one piece construction. The pump shaft is an extension of motor shaft and no coupling for pump shaft and motor shaft is allowed. The shaft should not come in direct contact with pumped liquid. Use of stainless steel sleeves will not be considered as substitute for stainless steel shaft.

i) **I□□□□□□□□□ A□□□□□r□□**

For transportable type of installation, a suitable stand / base frame type of arrangement shall be provided in such a way that in no case the pump will tilt.

Each pump set shall be provided with the suitable length of stainless steel lifting chain.

Following accessories to be included in scope of supply for pumps supported on discharge bend:

i. Pump pedestal and discharge connection("duck foot' type discharge bend)

ii. Guide rails, guide rail support brackets and lifting chain as appropriate

iii. Fasteners and anchor bolts

j) The major pump components shall be of material mentioned at Cl 9.00.00 of this sub-section and shall be with smooth surfaces, free of blow holes or other casting irregularities.

5.00.00 MOTOR RATING

Continuous motor rating (at 50 deg. C ambient) for pumps shall be at least ten percent (10%) above the maximum load demand of the driven equipment in the complete operating range (including run out condition) to take care of the system frequency variations.

6.00.00 P□□□□□□ D□□□□□ □□P□□ □

All metal surfaces coming in contact with the pumping media, other than stainless steel shall be protected by factory applied water based primer and finally covered by a two component high-solid top coating.

□.00.00 C□□□r□□□□d M□□□□□r□□□

For Submersible Type pumps all Control & Instrumentation is to be provided as per manufacturer's standard proven practice. If integral control system is provided for each pump, then Microprocessor / PLC / GIU based control system as per manufacturer's practice shall be provided. If Control system is provided externally for each pump, then it shall be implemented from DDCMIS. For both the cases, over all Control will be through DDCMIS. For details of DDCMIS refer C&I sections.

8.00.00 PERFORMANCE GUARANTEE TESTS

8.01.00 S□□□ T□□□

8.01.01 After the manufacture, all the pumps shall be subjected for performance test at the manufacturer's works to determine the power consumption and the head capacity characteristic in the presence of Employer's representative, as per requirements of Hydraulic Institute Standards, (HIS 11.6)

8.01.02 Hydrostatic test to be conducted to demonstrate that the hydraulic end, when assembled to the motor, will not leak or fail structurally when subjected to hydrostatic pressure as per HIS 11.6. NPSHR test also to be conducted to demonstrate the NPSHR requirement of pump.

8.01.03 Contractor shall submit along with his offer details of the proposed test facilities available for testing the pumps. The details must include the capacity, head, maximum motor rating, voltage level, sanctioned load and permissible starting current.

8.01.04 It may be noted that during shop tests no negative tolerance shall be permitted on head (H), capacity (Q) and the pump efficiency (n). Instruments accuracy used shall be plus or minus 1.5% or better for measurement of flow and plus or minus 0.5% or better for measurement of pressure and power.

8.01.05 Apart from the above, any testing if specified in subsection titled "Functional Guarantees and Liquidated damages" [subsection –IV of Part-A] of this Technical Specification shall also be conducted.

8.02.00 SITE TESTS

a) Manufacturer shall demonstrate at site the trouble free mechanical running of individual pumps.

b) The following parameters shall be measured during the demonstration test.

i) Current, Voltage and Motor Input Power.

ii) Frequency

iii) Bearing temperature & Motor winding temperature.

c) All interlocks and protections relating to the pumps, motors and motorised valves shall be tested.

c) <u>Parallel operation:</u>

There should be equal load sharing between pumps running in parallel with no abnormal vibrations, sound or hunting of head and flow. Load sharing between any pumps running in parallel should be within 10%.

GENERAL TECHNICAL REQUIREMENT OF ELEVATORS, CRANES AND HOISTS, WEIGH BRIDGE

EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-1 (3x800 MW)	TECHNICAL SPECIFICATION SECTION-VI PART-A BID DOC NO: CS-9585-001-2

ELEVATORS CRANES AND HOISTS

1.00.00 ELEVATOR

1.01.00 **P[illegible]r E[illegible]r [illegible]r TG B[illegible]d[illegible] S[illegible] B[illegible]d[illegible] Ad[illegible]r[illegible] B[illegible]d[illegible] [illegible]d ESP [illegible]r[illegible] (I[illegible])**

The Passenger elevators for TG Building, Service Building, ESP control room (if applicable) and Administration Building shall be as under.

(i) Two (2) nos. conventional type elevator having capacity of 13 persons for TG Building.

(ii) Two (2) nos. conventional type elevator having capacity of 13 persons for Service Building.

(iii) One (1) no. temporary Rack and pinion type elevator having capacity of 1000 kg for TG Building.

(iv) Two (2) nos. panoramic type elevator with five glass panels on rear side having capacity of 13 persons, for Administrative building.

(v) Three (3) nos. conventional type elevator having capacity of 10 persons for ESP control room (If applicable).

1.01.01 The scope shall include all items / accessories, service along with all electrical equipment etc. required to meet all design, installation, operation, safety, protection and other requirements of IS: 14665 (latest edition) (all parts), 'Lift' and service lifts'. This scope shall include all items / devices needed to comply with the requirements indicated elsewhere in the specification. The scope shall include but not limited to the following:

(a) 1 No. fireman's switch for each elevator.

(b) Machinery supporting Beam.

1.01.02 The location of Elevators shall be as per tender drawings enclosed with the specification.

1.01.03 Complete erection, testing and commissioning including all testing and commissioning materials, consumables and other tools and tackles required for erection.

1.01.04 To obtain necessary local administration permits / approvals and make arrangements for inspection and tests required thereby.

2.00.00 **CRANE & HOIST**

2.01.00 Suitable EOT Crane/HOT crane/monorail beams with hoists/chain pulley blocks of adequate capacity, to meet the erection and maintenance requirements are to be provided by the vendors for the various equipment/areas. Some of the areas/equipment not covered by TG hall EOT crane are indicated below. For balance areas/equipment, not listed herein, the requirements of Technical Specification shall be followed.

(a) Feed water heaters & deaerator.

(b) Various pumps & Heat Exchangers.

(c) Condenser water boxes (front & rear), vacuum pumps, CW butterfly valves, control fluid room etc.

(d) Auxiliary cooling water pumps and DM cooling water pumps of ECW systems and Plate heat exchangers.

(e) Central lube oil system room.

(f) Any other equipment.

The above requirement is indicative only; the requirement given in the respective chapter is to be adhered to.

GENERAL TECHNICAL REQUIREMENT OF ELEVATORS, CRANES AND HOISTS, WEIGH BRIDGE (CONT.)

SERVICE ELEVATORS CRANE HOIST & MONORAIL

1.00.00 SERVICE ELEVATORS

1.01.00 **DESIGN CRITERIA AND OPERATIONAL SPECIFICATION**

1.01.01 Design

Elevator shall be of conventional type for Service Building, TG building and of panoramic type with five glass panels on rear side for administrative building. The elevator shall meet the quality of international standard. The quality of glass panel on rear should be of highest grade from safety point of view and should meet the best standard.

1.01.02 No. of floors to be served shall be as per the specification and tender drawing of the Employer. Bidders shall quote variation in price for addition/deletion of one landing level in the relevant schedule of Forms and Procedures. However, bidder shall quote for above indicated landing levels in his base offer. No of floors and landing elevations are tentative only. The final landing elevations for all buildings shall be subject to approval by the Employer after award.

1.01.03 Elevators shall be designed based on following criteria:

i)	Design/construction/installation codes.	:	Latest edition of IS: 14665 (all parts)
ii)	Load carrying capacity	:	a) 884 kgs. (equivalent to 13 persons) for passenger elevators for service building, TG building and administrative building. b) 1000 kgs. for Rack & pinion elevator. separate details attached for design criteria. c) 680 kgs (equivalent to 10 persons) for passenger elevator of ESP control room (If applicable).
iii)	Rated speed	:	1.0 m/s.
iv)	Position of machine room	:	Directly above the elevator shaft.
v)	Machine room	:	Window air conditioner of minimum 2T capacity per elevator shall be provided by bidder.

1.02.00 **CONSTRUCTION**

Construction of the elevators shall specifically meet all requirements of the codes indicated and shall have following additional features:

i)	Flooring of Cabin	:	Vitrified ceramic tiles of mat finish.
ii)	Car enclosure & car panels	:	Stainless Steel
iii)	Handrails on 3 sides	:	Mirror Stainless Steel
iv)	False ceiling	:	Powder painted
v)	Car opening & Hoist way opening	:	Protected by central opening sliding Stainless Steel door
vi)	CABIN ACCESSORIES	:	The following accessories shall be provided : a) LED light fittings on car floor. b) Car control station c) Emergency stop switch. d) 5/15A, 3 pin plug socket with switch on top of lift car. e) Switches with Braille characters.

1. AUTOMATIC RESCUE DEVICE (ARD) - (BATTERY DRIVE):

   Bidder to provide a modern Advanced electronic drive system of “RESCUING Passenger Trapped in a ELEVATOR”.

2. EMERGENCY SAFETY DEVICES:

   The lift shall be provided with safety Device attached to the lift car frame and placed beneath the car. The safety device shall be capable of stopping and sustaining the lift car up at governor tripping speed with full rated load in car.

3. Elevator shall have Floor announcement system & Braille switches

1.02.01 All steel embedment for fixing landing doors/indicators etc. to the Elevator well shaft and fascia plate shall be supplied by the Bidder.

1.02.02 Guide rails complete with supporting brackets for the car and counter weights. Bidder to take care of granite tiles (approx 80 kg) to be provided for cabin flooring in selecting counter weights.

1.02.03 Elevator drive machines complete with electric motor, reduction gear unit, suspension ropes, buffers for the cars and the counter weights and other drive and control mechanism. All

foundation anchor bolts, sleeves, anchoring steel and any item required to complete the job satisfactorily shall be provided by the bidder. The bidder shall also provide for the grouting of anchor bolts, sleeves, anchoring steel, etc. and other anchorages

1.02.04 Any other steel works as well as all other accessories/components not specified in the specification but necessary for making the Elevator complete.

1.02.05 All building work including the supply of steel items, associated with installation of equipment in the machine room hoist way, hoist way door, frames and Elevator pit, shall form part of bidders scope of service, Bidder shall also provide the Elevator-well complete with foundation and brick walls around the lift-well together with overhead machine room. The machine room will be provided with R.C.C. floor slab with necessary pockets for anchor bolts and slots.

1.03.00 **OPERATION**

1.03.01 Elevator shall have provisions to meet following operational requirements :

a) Selective Duplex collective, automatic operation with or without attendant through illuminated push button station located inside the lift car.

b) Door operating shall be automatic door operation and electronic door protection system for opening/closing of car and landing doors.

c) Bidder shall provide car operating panel with luminous buttons, car position indication in car (both visual and audio) combined with direction arrows, overload warning indicator, battery operated alarm bell and emergency light and fan & hands free speaker telephone set with suitable battery, charger & controls.

d) Bidder shall provide emergency indicator to indicate the location of elevator in case of elevator being stuck up between the floors through automatic flashers (both audio & visual)

e) Bidder shall provide electronic door detector (Infra red curtain type).

f) Two push buttons, one for upward movement and the other for downward movement at each intermediate landing and one push button at each terminal landing shall be provided in order to call the car. Digital hall position indicator at all floors, tell lights at all floors shall also be provided by the bidder.

g) For facilitating the movement of visually & hearing impaired persons, hall lantern and car arrival chimes shall be provided.

h) All fixtures shall be in stainless steel face plates.

i) Push buttons shall be fixed in the car for holding the doors open for any length of the time required.

j) All other safety/protection/operation interlocks as required by IS: 14665 (latest edition).

1.04.00 **E□□□□□r E□□□r□□□:**

1.04.01 **E□□r□ □ □r:**

The driving motors shall conform to IS 325 and suitable for the Variable Voltage Variable Frequency (VVVF) application. All motors shall be squirrel cage induction type, suitable for operation at 415V (+/- 10% variation) , 3 phase, 3 wire, 50HZ (+3% to -5% variation) supply. Motors shall be provided with thermal class 130 (B) or better insulation.

1.04.02 **C□□r□:**

The controls shall be Variable Voltage and Variable frequency type and shall provide smooth and constant acceleration and retardation under all conditions of operation. Suitable control panel shall be provided in the machine room.

1.04.03 **C□□□□ □d □r:**

All the cables except trailing cables shall be as per IS: 1554-1 or IS-7098-I. The PVC outer sheath of these cables shall be flame retardant, low smoke (FRLS) type with the following FRLS properties.

a) Oxygen index of min. 29 (as per IS:10810 Part-58)

b) Acid gas emission of max. 20% (as per IEC-754-I).

c) Smoke density rating shall not be more than 60% (as per ASTMD-2843).

The circular trailing cables shall be either in accordance with IS 4289 Part-I (Elastomer insulated) or IS-4289 Part-II (PVC insulated). The flat type trailing cables if offered shall be in accordance with IEC-60227-6.

All wiring / cabling between the equipments in the lift machine room and that between the machine room and equipments in the lift well and at the landings shall be wired in HDP conduits/ galvanized steel conduits to be supplied by the contractor. Alternatively armored cables may be used.

1.04.04 **E□r□□□:**

The elevator structures and all Electrical equipment, including metal conduits shall be effectively earthed with the earth conductors provided in the machine room as per IS: 3043.

DATA SHEET

i)	Type of services	:	Passenger
ii)	Load carrying capacity	:	As per specification
iv)	Rated speed		One (1) m/s
v)	Total Travel	:	TG hall- As per layout Service Building- As per layout ESP Control room (If applicable)- As per Layout Administrative Building-As per layout
vi)	No. of floor to be served	:	TG hall, Service Building, Administrative Building & ESP control room (If applicable): - To be decided during detailed engineering.
vii)	Method of control	:	Variable voltage variable frequency (VVVF)
viii)	Position of M/c room	:	Directly above lift shaft
Ix)	Size of platform	:	As per IS14665 & manufacturer's standard latest.
x)	Size of lift well	:	-do-
xiii)	Specification code	:	As per IS: 14665 (5 parts) (Latest Edition).
xiv)	Design seismic co-efficient	:	According to the IS 1893-1977

RAC□ & PINION ELEVATOR

1.00.00 GENERAL

This specification is intended to cover design, engineering, supply, erection, testing and commissioning of the complete Rack & Pinion type Elevators as specified hereinafter complete in all respects and adequate for safe, efficient and trouble free operation of the elevator.

1.01.00 CODES AND STANDARD

The design, manufacture, inspection and testing of Elevator shall comply with all the currently applicable statutes, regulations and safety codes in the locality where the equipment is to be installed. The Elevator shall conform to the latest edition of standards and codes. Other internationally acceptable standards/ codes, which ensure equal or higher performance than those specified, shall also be accepted. Nothing in this specification shall be construed to relieve the contractor of the required statutory responsibility. In case of any conflict in the standard and this specification, the decision of the Project Manager shall be final and binding.

1.02.00 DESIGN AND CONSTRUCTION REQUIREMENTS

1.02.01 GENERAL

1.02.02 This section covers the design, engineering, fabrication, installation, commissioning and testing of the rack and pinion type vertical lift elevator including required enclosures, hoist, mast and guide rail, cab drive unit machinery buffers, power cable, control cable, mechanical and electrical equipment. The design of the elevator shall be in such a way that the elevator operation will be safe at all times.

1.02.03 Elevator shall be located as indicated in the relevant tender drawings and shall be capable of operating from the ground floor to the top interior platform with intermediate stops at all interior platforms.

1.02.04 All mechanical and electrical operating devices and Trailing cable shall be designed for outdoor operation with dusty and high humidity conditions and shall operate equally well in any ambient temperature as per project synopsis. Additionally, all mechanical and electrical components of the elevator shall be designed to withstand a temperature of 50°C ambient.

1.02.05 ENCLOSURES

A three-sided enclosure with one access door shall be provided for ground landing. At each platform landing above ground level, a one sided enclosure with access door shall be provided. Enclosures shall be fabricated from tubular steel and/or other structural shapes expanded metal or wire mesh of suitable height and primer coated with one coat of the manufacturer's standard primer and finish paint. The ground landing shall be provided at a suitable height above the foundation slab to ensure a safety space underneath the cage. The space under the landing shall be surrounded by foundation enclosure. The staircase shall be provided for access to the cage. Enclosure access doors shall be electrically and mechanically interlocked

	so that they remain closed and locked except when the cab is at a landing. Doors shall be bi-parting and swinging type. Base of the three-sided enclosure shall be securely anchored to the ground level floor slab using expansion type anchors.
1.02.06	Mast Mast shall be provided in sections of suitable length, consisting of tubular sections and/or structural shapes welded together to form a framework to which the rack is bolted. Mast shall be securely anchored to the building structure.
1.02.07	Cab
1.02.08	Cab frame shall be fabricated from tubular steel and/or other structural shapes enclosed with expanded metal or wire mesh.
1.02.09	Cab floor shall be of 6 mm thick Aluminum chequered plate or approved equivalent. Cab shall be attached to a framed structure and form an integral part with the drive mechanism located atop the cab.
1.02.10	Framed structure shall include guide rollers and safety hooks to ensure positive engagement of the rack and pinion to prevent cab disengagement in case of roller failure.
1.02.11	Cab roof shall be provided with an escape hatch electrically interlocked with the hoist control system. Tubular steel handrail shall enclose the cab roof for maintenance operations.
1.02.12	Cab door and landing level enclosure doors shall be electrically and mechanically interlocked to prevent the cab from being operated unless the cab door and landing level enclosure doors are fully closed and to prevent the doors from being opened while the cab is in motion.
1.02.13	One cabin fan and LED along with the fittings to be provided with one no. emergency light with battery & battery charger.
1.03.00	Drive Unit & Safety Device
1.03.01	Drive unit located on the cab shall be complete with AC squirrel cage induction motor, reduction gear, drive pinion and an over-speed governor. Drive unit shall incorporate an electric disc brake and an external manual brake release. The brake on the electric motor will be self adjusting type. In case of the power failure, the brake will be automatically applied & will stop the cab. A hand lever, which can be operated from the cage, is to be provided to enable the occupants to ease the brake and lower the cage to the bottom level. Motor shall be connected to a reduction gear, which drives the pinion.
1.03.02	An over-speed governor must be incorporated to protect the cab against over speed during the cab downward motion. At a predetermined speed higher than normal, the brake, mechanism shall be actuated and stop the downward motion of the cab gradually. The brake should remain locked on following this action and has to be manually reset before normal elevator operation can be resumed.
1.03.03	A remote control shall be provided for testing the safety device. The Contractor shall ensure that no individual is in cab during the test.

1.03.04 The drive system shall be designed so that it will be capable to operate smoothly without any tendency to rock or judder with all vertical, horizontal forces as well as the moments through the rack.

1.03.05 Suitable arrangement shall be provided to bring the cage safely to the ground by gravity in the event of power failure.

1.04.00 Buffers

Sufficient no. of buffers of spring loaded/hydraulic type shall be fitted below the cab. The buffer shall be capable of stopping the cab without permanent damage or deformation to themselves or any other part of the equipment. The no. of buffers shall be fixed as to ensure proper sharing of impact loads by all of them.

1.05.00 Power Supply

Two incomers (3 phase 3 wire) (one from Bus-A and one from Bus-B of the MCC) for the power supply to each elevator shall be provided with castle key interlocks.

1.06.00 Power and Control Cabinets

All electrical components furnished with the elevator shall be completely wired, energised and checked.

All electrical control devices shall be in enclosures. Equipment furnished shall also include the following:

(a.) Momentary contact push button for raise/lower control.

(b.) Reversing combination motor starter with a three phase thermal overload relay for motor protection. However, the control circuit in the elevator will have miniature circuit breakers.

(c.) Electric and mechanical interlocks on cab access door and landing level enclosure doors.

(d.) An ultimate three phase over travel limit switch which cuts off power and control supply in case of over travel. The switch can also be manually turned to off position.

Safety device as mentioned elsewhere in this specification

(e.) An alarm push button shall be provided in the cage. Alarm signal will be transferred to the auxiliary panel at elevator base.

The auxiliary panel at the base will have battery and battery charger for the alarm horn. Potential free contracts for remote alarm shall also be provided.

(f.) Reverse phase relay connected to prevent operation of the cab with improper phase rotation or failure in any phase in the power supply.

(g.) The cable shall be supported by brackets on the cage and guide rails. A cable trolley will keep it in tension and will be guided on the same rail as the cage. The trailing cable shall run through cable guides.

(h.) One auxiliary panel shall be furnished and mounted on the ground level enclosure. Panel shall be in enclosure equipped with a main “ON-OFF” switch, main Contractor,

relays, control transformer and MCB's, terminal blocks, and all other accessories required for normal operation of the elevator.

(i.) One main control panel shall be furnished and mounted on the top of cab. Panel shall be in enclosure equipped with necessary equipment like rectifier, battery, battery charger, contactors, breakers, control transformer and MCB's, thermal overload relays and all other equipment and accessories required for normal operation of the elevator.

(j.) Cab shall be controlled by a semiautomatic control system with push buttons for 'UP' 'Down' and 'Stop next landing'. The cab shall be controlled from inside and shall have painted placard located above the door. Cab shall be furnished with emergency alarm push button, limit switches, and all other necessary control devices required to ensure safe and continuous cab operation, One trailing cable shall connect the cab main control panel to the auxiliary panel at ground level to supply the cab with all power requirements. An extra core of equal size shall be provided for earthing of cab. Cable guides shall be installed every 6 meters to avoid entanglement of this cable.

(k.) Each landing assembly shall include a limit switch and push button control station installed and wired to a landing junction box.

(l.) All enclosures containing electrical, devices shall be provided with 240 Volts, single phase space heaters with adjustable thermostat control.

(m.) Cab shall be equipped with a 220 Volts, 20W fluorescent lights, fan, 5A, 220V, 3 pin receptacle, emergency light, battery & battery charger.

(n.) Control cabinets shall be sheet steel enclosed dust, weather and vermin proof. Sheet steel used shall be cold rolled and at least 2.0 mm thick. Degree of protection of control cabinet shall be as per relevant electrical section. Control cabinet shall be provided with hinged doors (s) with pad locking arrangements. All doors, removable covers and plates shall be gasketted all round with neoprene gaskets.

Each motor to be controlled from the control cabinet shall be provided with 3-pole isolating switch. HRC fuses, contactors shall be of AC4 duty class with

(o.) Thermal overload relays with single phase preventer. The isolating switch and contactor shall be rated at least 20% more than the connected motor full load current. The controller and resistor for motor shall confirm to relevant IS and shall be continuously rated for 150% full load current of the motor.

(p.) All fuses shall be of the HRC cartridge type mounted on plug in type of fuse base having a prospective current rating of not less than 80 kA.

(q.) All push buttons shall have 2NO and 2NC self reset contacts.

1.0□.00 **E□□□r□ □ □□r:**

The driving motors shall conform to IS 325 and suitable for the Variable Voltage Variable Frequency (VVVF) application. All motors shall be squirrel cage induction type, suitable for operation at 415V (+/- 10% variation) , 3 phase, 3 wire, 50HZ (+3% to -5% variation) supply. Motors shall be provided with thermal class 130 (B) or better insulation.

1.08.00 CABLES

Insulated armoured power /control cable shall be FRLS - HR insulated, stranded copper / aluminum conductors and shall be provided in accordance with IS: 1753 (latest edition) and IS: 1554 (Part-I) (latest edition).

Trailing cables in the elevator shaft should be specially designed for the specific service and shall conform to IS. Trailing cables shall be EPR insulated for 1.1 kV and shall be neoprene jacketed flexible cord.

Conductor accessories including terminal materials like glands, lugs etc. markers, tying materials, and cable supports shall be furnished and installed.

1.09.00 Earthing

(a.) GENERAL

Complete earthing system shall be furnished for all equipments and accessories of the elevator as per relevant IS.

(b.) MATERIALS

The earthing of all electrical items being supplied by the Contractor shall be in his scope. For earthing the various equipment, conductor sizes shall be as listed below :

(1.) Motor above 5 kW upto 30 kW 25x6 mm2 GI flat

(2.) Motors upto 5 kW and misc. small item like conduits,

junction boxes etc. 8 SWG GI wire

(3.) Cab earthing Additional core of trailing cable

The earthing strip/wire shall be connected to the earthing mat by the Contractor. Clamps and other hardware of iron or steel used with the grounding system shall be hot-dip galvanised. Bolts, washers, and nuts shall be hot-dip galvanised steel.

DATA SHEET: RACK & PINION ELEVATOR

1.0.0	GENERAL	
1.1.0	Type of Service	Passenger-Cum-Goods
2.0.0	DESIGN & CONSTRUCTION	
2.1.0	Carrying capacity	1000 Kg
2.2.0	Rated speed	Approx 25 - 40 m/min.
2.3.0	Total Travel	Shall be as per actual dimension of the Building
2.4.0	No. of floors to be served	As per requirement
2.5.0	Entrance	As per requirement
2.6.0	Min. cab Floor size (inside) WxLxH	1.3m x 2.0m x 2.1 m
2.7.0	Various heights of landing floors to be served	Suitable for working floors as indicated in the tender drawing.
2.8.0	Drive Motors (AC)	One (1) No.
2.9.0	Cab Flooring	6 mm thk. Al. Chequered plate.

SUB – SECTION – A-12

SURFACE PREPARATION & PAINTING

1.00.00 **SPECIFICATION OF SURFACE PREPARATION & PAINTING**

1.01.00 Surface preparation methods and paint/primer materials shall be of the type specified herein. If the contractor desires to use any paint/primer materials other than that specified, specific approval shall be obtained by the contractor in writing from the employer for using the substitute material.

1.02.00 All paints shall be delivered to job site in manufacturers sealed containers. Each container shall be labelled by the manufacturer with the manufacturer's name, type of paint, batch number and colour.

1.03.00 Unless specified otherwise, paint shall not be applied to surfaces of insulation, surfaces of stainless steel/nickel/ copper/brass/ monel/ aluminum/ hastelloy/lead/ galvanized steel items, valve stem, pump rods, shafts, gauges, bearing and contact surfaces, lined or clad surfaces.

1.04.00 All pipelines shall be Colour coded for identification as per the NTPC Colour-coding scheme, which will be furnished to the contractor during detailed engineering.

1.05.00 **SURFACE PREPARATION**

1.05.01 All surfaces to be painted shall be thoroughly cleaned of oil. Grease and other foreign material. Surfaces shall be free of moisture and contamination from chemicals and solvents.

1.05.02 The following surface preparation schemes are envisaged here. Depending upon requirement any one or a combination of these schemes may be used for surface preparation before application of primer.

SP1	Solvent cleaning
SP2	Application of rust converter (Ruskil or equivalent grade)
SP3	Power tool cleaning
SP4	Shot blasting (shot blasting shall be used as surface preparation method for hot worked pipes prior to application of primer)
SP4*	Shot blast cleaning/ abrasive blast cleaning to SA21/2 (near white metal) 35-50 microns
SP5	Shot blasting/ abrasive blasting.
SP6	Emery sheet cleaning/Manual wire brush cleaning.

1.06.00 **APPLICATION OF PRIMER/PAINT**

1.06.01 The paint/primer manuacturer's instructions covering thinning, mixing, method of application, handling and drying time shall be strictly followed and considered as part of this specification. The Dry film thickness (DFT) of primer/paint shall be as specified herein.

1.06.02 Surfaces prepared as per the surface preparation scheme indicated herein shall be applied with primer paint within 6 hours after preparation of surfaces.

1.06.03 Where primer coat has been applied in the shop, the primer coat shall be carefully examined, cleaned and spot primed with one coat of the primer before applying intermediate and finish coats. When the primer coat has not been applied in the shop, primer coat shall be applied by brushing, rolling or spraying on the same day

as the surface is prepared. Primer coat shall be applied prior to intermediate and finish coats.

1.06.04 Steel surfaces that will be concealed by building walls shall be primed and finish painted before the floor is erected.Tops of structural steel members that will be covered by grating shall be primed and finish painted before the grating is permanently secured.

1.06.05 Following are the Primer/painting schemes envisaged herein:

PS3 - Zinc Chrome Primer (Alkyd base) by brush/Spray to IS104.

PS3* - Zinc Chrome primer (Alkyd base) by dip coat.

PS4 - Synthetic Enamel (long oil alkyd) to IS2932.

PS5 - Red Oxide Zinc Phosphate primer (Alkyd base) to IS 12744

PS9 - Aluminium paint to IS 2339.

PS9* - Heat resistant Aluminium paint to IS-13183 Gr.-1

PS13 - Rust preventive fluid by spray, dip or brush.

PS14 - weldable primer-Deoxaluminate or equivalent.

PS16 - High Build Epoxy CDC mastic `15' .

PS17 - Aliphatic Acrylic Polyurethane CDE134 ,%V=40.0(min.)

PS18 - Epoxy based TiO2 pigmented coat

PS19 - Epoxy Zinc rich primer (92% zinc in dry film (min.), %VS=40.0(min.)

PS-20 - Epoxy based finish paint

1.06.06 All weld edge preparation for site welding shall be applied with one coat of wieldable primer.

1.06.07 For internal protection of pipes/tubes, VCI pellets shall be used at both ends after sponge testing and ends capped. VCI pellets shall not be used for SS components and composite assemblies.

1.06.08 SG membrane walls and other Flue gas swept pressure part surfaces shall be applied with appropriate primer for protection of surfaces during transit, storage and erection.

1.06.09 a) All un-insulated equipments, pipes, valves etc covered in sub-section A-08 (Steam Turbine & Auxiliary system) shall be painted with paint not inferior to Epoxy resin based paints with minimum DFT of 150 micron.
The paint shall be applied in three stages i.e. primer, intermediate and finish coats in following manner:

- Primer coat – Epoxy based zinc phosphate
- Intermediate - Epoxy based TiO2 pigmented coat
- Finish coat - Epoxy based finish coat

b) Equipment, pipes etc. with high temperature shall be painted with heat resistant aluminum paint (to be selected based on the service condition of component as per IS-13183). Two coats of paint shall be applied with total DFT 40 micron.

c) Surface preparation before painting shall be carried out according to requirement indicated in this sub-section and international standard

1.06.10

A) Specification for the application of Epoxy coating for internal protection of DM tank & other vessels/tanks (as applicable) shall be as follows:

Primer : One coat of unmodified epoxy resin along with polymide hardener.

Paint : Two (2) coats unmodified epoxy resin along with Aromatic adduct hardener.

Total thickness of primer and paint should not be less than 400 microns.

B) Specification for application of chlorinated Rubber paint for external protection vessel, tanks, piping, valves & other equipments shall be as follows:

i) For Indoor vessel, tanks, piping, valves & other equipments:

(a) Surface preparation shall be done either manually or by any other approved method.

(b) Primer coat shall consist of one coat of chlorinated rubber based zinc phosphate primer having minimum DFT of 50 microns.

(c) Intermediate coat (or under coat) shall consist of one coat of chlorinated rubber based paint pigmented with Titanium dioxide with minimum DFT of 50 microns.

(d) Top coat shall consist of one coat of chlorinated rubber paint of approved shade and colour with glossy finish and DFT of 50 microns.

Total DFT of paint system shall not be less than 150 microns.

ii) For Outdoor vessel, tanks, piping, valves & other equipments:

(a Surface preparation shall be blast cleared using non-siliceous abrasive after usual wire brushing, which shall conform to Sa 2-1/2 Swiss Standard.

(b Primer coat shall consist of one coat of epoxy resin based zinc phosphate primer having minimum DFT of 100 microns.

(c) Intermediate coat (or under coat) shall consist of epoxy resin based paint pigmented with Titanium dioxide with minimum DFT of 100 microns.

(d Top coat shall consist of one coat of epoxy paint suitable pigmented of approved shade and colour with glossy finish and DFT of 75 microns. Additionally finishing coat of polyurethane of minimum DFT of 25 microns shall be provided.

The paint may be applied in one coat, in case high built paint is used, otherwise two coats shall be applied.

Total DFT shall not be less than 300 microns.

1.06.11 Primer/Painting Schedule

Sl. No	Description		Surface Preparation	Primer Coat			Intermediate Coat			Finish Coats			Total Min. Painting DFT (Microns)	Colour Shade
				Type of Primer	No. of Coats	Min. DFT / coat (Microns)	Type of coating	No. Coats	Min. DFT/ Coat (Microns)	Type of coating	No. Coats	Min. DFT/ Coat (Microns)		
A) Power Cycle Piping														As per NTPC Colour shade/ coding scheme
1.	All insulated Pipings, fittings/ components, Pipe clamps, Vessels/Tanks, Equipments etc.		SP3/SP4	PS9*	1	20	-	-	-	PS9*	1	20	40	
2.	All un-insulated Pipings, fittings/ components, Pipe clamps, Vessels/Tanks, Equipments etc.	Design temperature < or equal to 60^0C	SP3/SP4	PS 5	2	25	-	-	-	PS 4	3 **$**	35 **$**	155 **$**	
		Design temperature above 60^0C-200^0C	SP3/SP4	PS 9*	1	20	-	-	-	PS9*	1	20	40	
		Design temperature > 200^0C	SP3/SP4	PS9*	1	20	-	-	-	PS9*	1	20	40	
3	Constant Load Hanger (CLH) and Variable Load Hanger (VLH)		SP4*	PS19	1	40	-	-	-	PS17	1	30	70	

4	Piping hangers/ supports (other than (3) above. (un-insulated)		SP4 (SP6 - for cleaning of weld joints after erection,)	PS 5	1	40	PS 4	1	40	PS 17	1	40	120
	Valves												
5.	Cast/Forged	Design temperature < or equal to 60 degC	SP1/SP2/SP3	PS4/PS9	1	40	Polyamide Epoxy	1	100	PS17	1	40	180
		Design temperature above 60 degC and up to 200 degC	SP1/SP2/SP3	PS 9*	1	20	-	-	-	PS9*	1	20	40
		Design temperature above 200 degC	SP1/SP2/SP3	PS9*	1	20	-	-	-	PS9*	1	20	40
6.	All auxiliary Structural Steel components for pipe supports	Outside TG building and in SG envelope	SP4*	Inorganic Ethyl Zinc Silicate	1	75	PS18	1	75	a))Epoxy coat b)Final coat of paint PS17	2 1	35 30	250

		Within TG building	SP4*	-do-	1	35	PS18	1	35	a))Epoxy coat b)Final coat of paint PS17	2 1	25 30	150
7.	Weld Edges		SP6 (Hand cleaning by wire brushing)	PS13 (Weldable primer)	1	25	-	-	-	-	-	-	25

1. $ The first 2 finished coats (total min. DFT of 70 microns) shall be done at shop and the 3rd finish coat (min. DFT 35 Microns) shall be applied at site.
2. For valves below 65NB and temperature upto and including 540 DegC, Parkerizing/zinc phosphate corrosion resistant coating as per ASTM F1137 is also acceptable in lieu of Aluminum paint.
3. For corrosion protection of threaded hanger rods and variable spring cages, electro galvanizing in full compliance to minimum Corrosion category C3 as per EN ISO12944 is also acceptable.
4. For spring cages, 2 coats of 30 µm (min) zinc-rich epoxy resin primer with zinc content> 80 weight% in dry film followed by 2 coats of 30 µm (min) top coat of Acrylic resin Co-polymerisate with a total combined minimum DFT of 120µm is also acceptable in lieu of above specified paint scheme.
5. For corrosion protection for all inner parts of the hangers shall be at least in full compliance to Corrosion category C3 as per EN ISO12944.

B) Steam Generator & Auxiliaries:

1	All surfaces with temperature 95°C or less and which are insulated	SP3/SP4	PS 5	2	30	-	-	-	PS 4	2 **$**	20 **$**	100 **$**
2	All surfaces with temperature above 95°C and which are insulated	SP3/SP4	PS9*	1	20	-	-	-	PS9*	1	20	40

Note: **1)** SG membrane walls and other Flue gas swept pressure part surfaces shall be applied with appropriate primer for protection of surfaces during transit, storage and erection.

2) For valves below 65NB and temperature upto & including 545 Deg.C, Parkerizing/zinc phosphate corrosion resistant coating as per ASTM F1137 is also acceptable in lieu of Aluminum paint.

C) LOW PRESSURE PIPING

1	All Pipes, fittings / components, valves, Equipments etc.	SP3/SP5	PS3/ PS5	2	25	PS 4	1	30	PS 4	2	35	150	As per NTPC Colour shade/ coding scheme
2	Stainless steel surface, Galvanized steel surface and gun metal surface.	No Painting											
3	On the internal surface for pipes 1000 Nb and above	A coat of primer followed by hot coal-tar enamel or coal tar epoxy painting (cold) shall be applied.											

D) Fire Detection & Protection System, Compressed air system, Hydrogen generation plant and Air-conditioning & Ventilation System												
For Fire Detection & Protection System, Surface preparation and painting of Fire Water Storage Tanks, all Steel Surfaces (external) exposed to atmosphere (outdoor & indoor installation), Deluge Valves, Alarm Valves, Foam monitors, Water monitors, Foam Proportioning equipments, Foam makers, etc. should be as per the Part-B, Sub Section-A-18, Fire Detection & Protection System For Air Conditioning System, Surface preparation and painting of all the steel surfaces (external) exposed to atmosphere (outdoor & indoor installation), centrifugal fans – Casing etc. should be as per the Part-B, Sub Section-A-17, Air Conditioning System. For Ventilation System, Surface preparation and painting of all the steel surfaces (external) exposed to atmosphere (outdoor & indoor installation), centrifugal fans – Casing etc. should be as per the Part-B, Sub Section-A-30, Ventilation System. For compressed air system, Surface preparation and painting of all the steel surfaces should be as per the Part-B, Sub Section-A-16 compressed air system. For hydrogen generation plant, Surface preparation and painting should be as per the Part-B, Sub-Section-A-19 hydrogen generation plant.												
E) ESP												
1	All surfaces with surface temperature 95°C or less (with insulation)	SP3/SP4	PS3/ PS5	1	25	-	-	-	PS 4	1	30	55
2	All surfaces with surface temperature above 95°C (with or without insulation)	SP3/SP4	PS5	2	30	-	-	-	-	-	-	60

General Notes (Applicable for all above points A to E)

i) Painting specification for all surfaces with surface temperature 95°C or less (un-insulated) that are not covered above shall be same as that given in Civil Sub-section, Part-B, Section-VI for corrosion protection of steel structures.

ii) Painting specification for inside surfaces (such as inner surfaces of ducts/ tanks/ mills/ dampers/ ESP etc.) that are not covered specifically in above clauses, shall be provided with 2 coats of suitable primer i.e. PS5/ PS9 (Total DFT 60/40 micron) based on the temperature.

F) FGD System
(i) Surface preparation shall be blast cleaned conforming *to* Sa *2-1/2* Swiss Standard. (ii) Primer coat shall consist of epoxy resin based zinc phosphate primer having minimum DFT of 100 microns. (iii) Intermediate coat (or under coat) shall consist of epoxy resin based paint pigmented with Titanium dioxide with minimum DFT of 100 microns. (iv) Top coat shall consist of one coat of epoxy paint suitable pigmented of approved shade and colour with glossy finish and DFT of 75 microns. Additionally finishing coat *of* polyurethane of minimum DFT of 25 microns shall be provided.

SUB-SECTION VI

MANDATORY SPARES

1.00.00 **SPARES**

The Bidder shall include in his scope of supply all the necessary Mandatory spares, start up and commissioning spares and recommended spares and indicate these in the relevant schedules of the Bid Form and Price Schedules. The general requirements pertaining to the supply of these spares is given below:-

1.01.00 **MANDATORY SPARES**

(a) The list of mandatory spares considered essential by the Employer is indicated in Section VI, Part-F chapter. The bidder shall indicate the prices for each and every item (except for items not applicable to the bidders design) in the 'Schedule of mandatory Spares' whether or not he considers it necessary for the Employer to have such spares. If the bidder fails to comply with the above or fails to quote the price of any spare item, the cost of such spares shall be deemed to be included in the contract price. The bidder shall furnish the population per unit of each item in the Bid Forms and Price Schedules. Whenever the quantity is mentioned in "sets" the bidder has to give the item details and prices of each item.

(b) The Employer reserves the right to buy any or all the mandatory spares parts.

(c) The prices of mandatory spares indicated by the Bidder in the Bid Proposal sheets shall be used for bid evaluation purposes.

(d) All mandatory spares shall be delivered at site at least two months before scheduled date of initial operation of the first unit. However, spares shall not be dispatched before dispatch of corresponding main equipments.

(e) Wherever quantity is specified both as a percentage and a value, the Bidder has to supply the higher quantity until and unless specified otherwise.

(f) In case specified spares are not applicable to a particular design offered by the bidder, functionally equivalent applicable spares pertaining to the offered design shall be provided in quantities as per specified spares.

1.02.00 **RECOMMENDED SPARES**

(a) In addition to the spare parts mentioned above, the contractor shall also provide a list of recommended spares for 3 years of normal operation of the plant and indicate the list and total prices in relevant schedule of the Bid Form and Price Schedules. This list shall take into consideration the mandatory spares specified in this Section-VI, part-F and should be independent of the list of the mandatory spares. The Employer reserves the right to buy any or all of the recommended spares. The recommended spares shall be delivered at project site at least two months before the scheduled

date of initial operation of first unit. However, the spares shall not be dispatched before the dispatch of the main equipment.

(b) Price of recommended spars will not be used for evaluation of the bids. The price of these spares will remain valid upto 6 months after placement of Notification of Award for the main equipment. However, the Contractor shall be liable to provide necessary justification for the quoted prices for these spares as desired by the Employer.

1.03.00 **START-UP & COMMISSIONING SPARES**

Start-up and commissioning spares are those spares which may be required during the start-up and commissioning of the equipment/system. All spares used till the plant is handed over to the employer shall come under this category. The Contractor shall provide for an adequate stock of such start up and commissioning spares to be brought by him to the site for the plant erection and commissioning. They must be available at site before the equipments are energized. The unused spares, if any, should be removed from there only after the issue of Taking Over certificate. All start up spares which remain unused at the time shall remain the property of the Contractor.

1.04.00 The Bidder shall include in his scope of supply all the necessary Mandatory spares, start up and commissioning spares and recommended spares and indicate these in the relevant schedules of the Bid Form and Price Schedules. The general requirements pertaining to the supply of these spars is given below.

2.00.00 The Contractor shall indicate the service expectancy period for the spares parts (both mandatory and recommended) under normal operating conditions before replacement is necessary.

3.00.00 All spares supplied under this contract shall be strictly inter changeable with the parts for which they are intended for replacements. The spares shall be treated and packed for long storage under the climatic conditions prevailing at the site e.g. small items shall be packed in sealed transparent plastic with desecrator packs as necessary.

4.00.00 All the spares (both recommended and mandatory) shall be manufactured along with the main equipment components as a continuous operation as per same specification and quality plan.

5.00.00 The contractor will provide Employer with cross-sectional drawings, catalogues, assembly drawings and other relevant documents so as to enable the Employer to identify and finalise order for recommended spares.

6.00.00 Each spares part shall be clearly marked or labelled on the outside of the packing with its description. When more than one spares part is packed in a single case, a general description of the content shall be shown on the outside of such case and a detailed list

	enclosed. All cases, containers and other packages must be suitably marked and numbered for the purposes of identification.
7.00.00	All cases, containers or other packages are to be opened for such examination as may be considered necessary by the Employer.
8.00.00	The contractor will provide the Employer with all the addresses and particulars of his sub suppliers while placing the order on vendors for items/components/equipments covered under the contract and will further ensure with his vendors that the Employer, if so desires, will have the right to place order for spares directly on them on mutually agreed terms based on offers of such vendors.
9.00.00	The Contractor shall warrant that all spares supplied will be new and in accordance with the contract Documents and will be free from defects in design, material and workmanship.
10.00.00	In addition to the recommended spares listed by the contractor, if the employer further identifies certain particular items of spares, the contractor shall submit the prices and delivery quotation for such spares within 30 days of receipt of such request with a validity period of 6 months for consideration by the Employer and placement of order for additional spares if the Employer so desires.
11.00.00	The Contractor shall guarantee the long term availability of spares to the Employer for the full life of the equipment covered under the contract. The Contractor shall guarantee that before going out of production of spares parts of the equipment covered under the Contract, he shall give the Employer at least 2 years advance notice so that the latter may order his bulk requirement of spares, if he so desires. The same provision will also be applicable to sub-contractors. Further, in case of discontinuance of manufacture of any spares by the Contractor and/or his sub contractors, Contractor will provide the Employers, two years in advance, with full manufacturing drawings, material specifications and technical information including information on alternative equivalent makes required by the Employer for the purpose of manufacture/procurement of such items.
12.00.00	The bidder to provide datasheets/assembly drawings of the manufacturer/ any other relevant document showing Bill of Material(s), Make, Model Number, Part Number etc. through which the mandatory spares to be supplied can be uniquely identified. This would facilitate the Employer to assign a unique code to each of the mandatory spare as brought out in GCC. The bidder shall extend all necessary assistance in this regard.

SUB – SECTION – A-29

PRE-COMMISSIONING & COMMISSIONING ACTIVITIES

PRE-COMMISSIONING ACTIVITIES COMMISSIONING OF FACILITIES AND INITIAL OPERATIONS

1.00.00 **GENERAL**

1.01.00 The pre-commissioning and commissioning activities including Guarantee tests, checks and initial operations of the equipment furnished and installed by the Contractor shall be the responsibility of the Contractor as detailed in relevant clauses in Technical Specification. The Contractor shall provide, in addition, test instruments, calibrating devices, etc. and labour required for successful performance of these operations. If it is anticipated that the above test may prolong for a long time, the Contractor's workmen required for the above test shall always be present at Site during such operations.

1.02.00 It shall be the responsibility of the Contractor to provide all necessary temporary instrumentation and other measuring devices required during start-up and initial operation of the equipment systems which are installed by him. The Contractor shall also be responsible for flushing & initial filling of all oils & lubricants required for the equipment furnished and installed by him so as to make such equipment ready for operation. The Contractor shall be responsible for supplying such flushing oil and other lubricants unless otherwise specified elsewhere in these specifications & documents.

1.03.00 The Contractor upon completion of installation of equipments and systems, shall conduct pre-commissioning and commissioning activities, to make the facilities ready for sustained safe, reliable and efficient operation. All pre-commissioning/commissioning activities considered essential for such readiness of the facilities including those mutually agreed and included in the Contractors quality assurance program as well as those indicated in clauses elsewhere in the technical specifications shall be performed by the Contractor.

2.00.00 **TESTING / COMMISSIONING PROCEDURES**

The contractor shall submit his testing / commissioning check lists and procedures for various equipments / systems covered under the contract at least 18 months before the actual commissioning of the equipments / systems for review and approval of employer.

The testing / commissioning procedures are to be of a standard format in order to maintain consistency of presentation, content and reporting. The list of commissioning check lists and procedures to be submitted and their content details shall be agreed upon during preaward discussions.

An indicative list of Testing / Commissioning procedures/schedules and Standard Checklists and the details regarding the contents of testing/commissioning are enclosed as annexure at the end of this sub-section of section-VI, Part B. The actual list of such equipments / systems shall depend on the equipments / systems being supplied by the contractor.

i) Annexure-I : Standard Checklist of items

ii) Annexure-II : Testing / Commissioning Procedure/schedules

iii) Annexure-III : Commissioning procedures requiring approval of Employer.

iv) Annexure – IV : Demonstration/Acceptance test procedures during Commissioning/Initial operation

v) Annexure – V : Brief write up on Contents of Testing / Commissioning Procedures

Procedure/schedules shall be approved by the employer.

3.00.00 **PRECOMMISSIONING & COMMISSIONING ACTIVITIES**

3.01.00 **G□□□r□□**

The pre-commissioning activities including some of the important checks & tests for certain major equipment/ systems (as a minimum) are described below, although it is the Contractor's responsibility to draw up a detailed sequential & systematic list of checks / tests and various activities / procedures connected with pre-commissioning of the complete facilities with all systems, sub-systems and equipment supplied and installed by him and get the same approved by the Employer.

3.02.00 **PRE-COMMISSIONING ACTIVITIES/TESTS:**

S□□□□ G□□□r□□□r

3.02.01 **H□dr□□□□□ T□□□□□□ □□Pr□□□□r□ P□r□□**

On completion of installation of the Steam Generator pressure parts and high pressure boiler external piping & non boiler external piping a hydraulic test in accordance with the requirements of the Indian Boiler Regulations, shall be performed by the Contractor. However, making use of valves/control valves supplied by others and installed on the contractor's piping system during hydraulic testing shall be subjected to the acceptance of respective valve supplier otherwise hydraulic cap/blanking arrangement as required shall be used. The procedure adopted for hydraulic test and preservation shall have the prior approval of the Employer. The detailed schemes and procedure for carrying out hydraulic testing shall be prepared and furnished by the contractor and it shall be discussed and finalized during detailed engineering stage. The water for hydraulic test shall be made alkaline by addition of suitable chemicals. After the test, the Steam Generator and high pressure external piping shall be suitably drained and preserved.

All blank flanges, removable plugs, temporary valves, pipes & fittings, spools, other accessories and services required for carrying out hydraulic testing of boiler external pipings & non boiler external pipings and boiler & its pressure parts shall be furnished by the Contractor. The pressurization equipment including water piping and any chemicals for preservation, needed for the above test shall also be furnished by the Contractor. Any defect noticed during the testing shall be rectified and the unit shall be retested by the Contractor.

In the case of branch connections/ tap-off piping (in others scope) from contractor's scope of piping are not ready or not erected at the time of hydrostatic testing of piping in contractor's scope, then the contractor to supply/use necessary blanking arrangement as required at these tap-off /branch connections. The hydraulic test shall be considered successful only on certification to that effect by the concerned inspecting authority as per the provision of the IBR and the Project Manager.

3.02.02 **A□r & G□□ T□□□□□□□□ T□□□**

After completion of installation of furnace tubes and/or inner skin casing wherever applicable ducts and airheaters, and before commencement of application of thermal insulation a test shall be performed on the Steam Generator by the contractor to prove or to establish the tightness of the erected equipments from the outlet of FD fan through Steam Generator to the stack. Such test shall be done, as far as possible, with all mountings like soot blowers etc. installed in position. The procedure adopted for such tests shall have the prior approval of the Employer. Normally physical leak detection method by pressurising the section under test by running FD Fan / PA Fan / Temporary blower, as the case may be, is adopted. The contractor may adopt any other better method of testing.

All equipments including any temporary blanking, if required, for the above test shall be provided by the Contractor.

The Contractor's air and gas tightness test procedure shall be such that it shall enable conductance of air/gas tightness test on the ducts in segmented manner (as and when these duct segments are ready), so that these duct segments can be immediately released for application of insulation after their air/gas tightness tests. Contractor shall made all necessary arrangement for conducting tests in this manner. Any blanking etc. on the duct side required for testing of duct segments shall be provided by Contractor. Contractor shall bring fan / blower (s) of adequate size / capacity and other necessary instruments so that these tests can be conducted without necessity of FD / PA fans. The above equipment shall be brought to site by the Contractor on temporary basis and shall be taken back after successful completion of air / gas tightness test.

3.02.03 **C□□□ □□□C□□□□□□ □□Pr□□□□r□ P□r□□**

The Contractor shall perform thorough and efficient cleaning operations of all the internal parts of the boiler, like economiser, water wall / evaporator, separator, feed water line, piping, start-up recirculation lines and associated piping and all other pressure parts and associated high pressure piping covered under these specifications (except those portions which are to be steam blown).

The cleaning operation shall consist of De-mineralised (DM) water flushing, the chemical cleaning using acids like hydrofluoric acid or as recommended by the manufacturer, DM water rinsing, DM water flushing, nitrogen capping etc. Complete chemical cleaning procedure, the scheme and layout including parameters of the pumps, size of tanks, materials of construction, the rate of consumption and total requirements of steam and water for such cleaning process shall have the approval of the Employer.

The Contractor shall furnish all labour, materials such as the required chemicals and other consumables, all equipment such as acid/chemical transfer and acid/chemical circulating pumps complete with drive motors, acid storage and acid/chemical mixing tanks, all temporary piping, valves and specialities and local instruments for pressure, temperature and flow measurements and any other items needed to carry out the process. All equipment required for chemical cleaning of Steam Generator shall be supplied by the contractor.

The Contractor shall take care to dispose off the used chemicals and the effluents from the cleaning operations, after neutralisation, meeting all the statutory regulations and in a manner acceptable to the Project Manager and which would comply with the norms of the State Pollution Control Board. This includes construction of suitable neutralization pit, channels, disposal equipments etc.

The Contractor shall specifically make all necessary arrangements for prevention of any fire accidents, explosions etc. during the performance of the chemical cleaning operations.
The Contractor shall ensure that during the cleaning process the procedure adopted shall be such as to consume minimum demineralized water.

The cleaning procedure shall include final flushing and draining of the boiler under a nitrogen gas cap and/or filling the boiler with inhibited water or any other proven procedure recommended by the manufacturer for the preservation of the boiler which is acceptable to the Employer. The Contractor shall furnish a detailed procedure for boiler preservation during detailed engineering for Employer's approval.

All equipment needed for such preservation including the nitrogen cylinders, interconnecting piping and any regulating equipment for N2 cap and other preservatives shall be provided by the Contractor for the Steam Generator and the same shall also become the property of the Employer after completion of the chemical cleaning.

The Contractor shall provide adequate safety and protective equipment for all his employees and ensure that they are worn at all times of danger. Specialized treatment equipment (such as required for first aid when using hydrofluoric acid/chemical) must be provided at the place of handling acid/chemical. An acid/chemical cleaning report and log of each cleaning must be provided by the Contractor to the Employer, immediately after the cleaning operation.

3.02.04 **S□□□□ B□□□ □□□**

Steam blowing of complete Superheaters, Reheaters and various boiler external piping and non boiler external piping shall be carried out by the Contractor as per requirements/scope of work (indicated in Part-A & Part-B, Section-VI) of this specification. Temporary materials as required for steam blowing of these piping systems shall be supplied by the contractor.

Steam blowing of contractor's scope of piping systems shall be performed without valves/control valves supplied in steam blowing circuit otherwise valve supplier's acceptance to include these valves for steam blowing operation is to be submitted by the contractor. Based on the above the Contractor shall give recommended procedures, method of blowing and scheme for steam blowing indicating clearly additional system, if any, to be cleaned by steam blowing and furnish data/ write-up/ layouts/ drawings to that effect to the Employer for approval.

The Contractor shall furnish his recommendations regarding use of various test equipments and instruments and termination/acceptance criteria for steam blowing, which in any case shall meet the steam turbine-generator requirements.

The systems which should be ready and operational before steam blowing shall be made ready/operational by the Contractor by the scheduled date for starting of steam blowing.

For equipments/components installed on high pressure external piping, such as various thermo-wells, flow meter, control valves, HP/LP Bypass valves etc., the Contractor shall comply with guidelines to be followed during steam blowing, with respect to removal / blanking / replacement of such items their internals etc. by spool pieces as given by the respective manufacturer/sub-contractor.

Supply of all such spools (as above) and/or blanks, temporary piping and supports etc. as required, cutting / welding / edge preparation and rewelding required for blanking, temporary piping connection and/or for replacements by spool pieces shall be the responsibility of the Contractor. After steam blowing removal of spool pieces & temporary piping and reinstallation of various components, shall also be the responsibility of the Contractor.

In the case of branch connections/ tap-off piping are not ready or not erected at the time of steam blowing operation then the contractor to supply/use necessary blanking arrangement as required at these tap-off / branch connections.

It will be the responsibility of the Contractor to operate the Steam Generator and its accessories equipment to generate adequate steam at the parameter and quality in line with the requirements of steam blowing procedure. The Contractor shall make adequate provisions for temporary enhancement of fuel oil firing capacity of the steam generators by changing oil gun tips etc. as may be required so as to be able to conduct complete steam blowing operation by oil firing alone. All necessary precautions to avoid fires and cold end corrosion of Air preheater, during such oil firing at enhanced SG loads, shall be taken by the Contractor.

The Contractor shall ensure successful and timely completion of steam blowing of all systems and will render all help/services as required including:

(i) Services of test/operating personnel/supervisors.

(ii) Extending all cooperation during erection, pre-commissioning of plant and equipment to be made ready and operational before starting steam blowing.

(iii) Extending all cooperation for interface engineering of equipments/components of temporary system required for steam blowing operation.

(iv) Contractor's engineers shall be available for all coordination meetings arranged by the Employer for finalizing the details of temporary system for steam blowing.

For the steam blowing operation, steam conditions like pressure, temperature etc. at the Steam Generator outlet shall be so selected that a minimum cleaning ratio/ disturbance factor of more than 1.4 is achieved. A cycle of heating, cooling and blowing/ purging, is to be repeated to ensure thorough cleaning of the interior of the pipes/ tubes etc. The final indication of cleanliness shall be demonstrated by purging through target plates positioned at the discharge point.

3.02.05 **SCR SYSTEM**

Complete pre-commissioning work including tests of facilities such as pressure drop test of SCR system and all other tests as mutually agreed in the Contractor's quality assurance program as well as those identified in the specification.

3.02.06 **ESP**

Complete pre-commissioning work including tests of facilities such as air and gas tightness tests of ESP, pressure drop test of ESP, gas distribution test of ESPs etc. and all other tests as mutually agreed in the Contractor's quality assurance program as well as those identified in the specification.

3.02.07 **FGD S□□□□□**

3.02.07.01 **A□r □□d G□□ T□□□□□□□□ T□□□**

After completion of installation of Booster fans (if required), ducts & absorber, and before commencement of application of thermal insulation a test shall be performed on the FGD system by the contractor to prove or to establish the tightness of the erected equipments. The procedure adopted for such tests shall have the prior approval of the Employer. Normally physical leak detection method by pressurizing the section under test by running Temporary blower is adopted. The contractor may adopt any other better method of testing.

All equipments including any temporary blanking, if required, for the above test shall be provided by the Contractor.

The Contractor's air and gas tightness test procedure shall be such that it shall enable conductance of air/gas tightness test on the ducts in segmented manner (as and when these duct segments are ready), so that these duct segments can be immediately released for application of insulation after their gas tightness tests. Contractor shall made all necessary arrangement for conducting tests in this manner. Any blanking etc. on the duct side required for testing of duct segments shall be provided by Contractor. Contractor shall bring fan / blower (s) of adequate size / capacity and other necessary instruments so that these tests can be conducted. The above equipment shall be brought to site by the Contractor on temporary basis and shall be taken back after successful completion of air / gas tightness test.

3.02.07.02 All pre-commissioning tests & activities as indicated in Annexure-I, II & III and elsewhere in the technical specification shall be performed by the Contractor.

3.02.08 Any other pre-commissioning activity such as floating of safety valves etc. as considered essential for readiness of facilities for commencement of commissioning activities shall also be undertaken by the Contractor.

3.03.00 **D□□ □□□r□□□□/A□□□□□□□□□ □□□□□ d□r□□ C□□ □ □□□□□□□□/I□□□□□ O□r□□□□**

The following tests shall be demonstrated during commissioning for which the bidder has to furnish the procedure and get the approval of the employer:

3.03.01 **S□r-□□□L□□d□□□U□□□d□□ □□d S□□d□□ □ C□□□□□□□□ (F□r T□r□□□ G□□r□□r)**

(i) **U□□S□r□U□**

Start-up time (upto full load), and loading capabilities for the Turbine Generator together for cold start conditions (greater than 36 hours shutdown), warm start conditions (between 8 and 36 hours shutdown) and hot start conditions (less than 8 hours shutdown) as indicated by the Contractor in the offer and accepted by the EMPLOYER shall be demonstrated, ensuring that the various turbine operational parameters like vibration, absolute and differential expansion, eccentricity and steam-metal temperature mismatch etc. are within design limits.

(ii) **S□dd□□ T□□□L□□□ □□Ex□r□□L□□d**

On occasions, the steam turbine generator unit may experience sudden total loss of all external load. Under these conditions, the steam turbine generator unit shall not trip but shall continue to be in operation under the control of its speed governor to supply power for the plant auxiliary load with HP-LP bypass in operation while staying within the agreed limits of steam to metal temperature mismatch, exhaust hood temperature, absolute and differential expansion, vibration and eccentricity. The same shall be demonstrated. Further, the provisions of Part-B, Section-VI, shall also be complied with.

(iii) **S□□□□ M□□□□T□□ □□r□□□r□ M□□□ □□□□ L□□ □□□□□□**

The steam-metal temperature differential for cold, warm and hot start up, loading / unloading and shutdown conditions shall be within the permissible limits indicated by the Bidder in the offer and accepted by the Employer.

3.03.02 **T□r□□□ G□□r□□r S□□C□□□□□□□**

The steam turbine generator unit shall be capable of delivering at generator terminals the output as indicated by the BIDDER in the heat balances submitted along with his bid, under the following condition.

(a) Maximum continuous output at generator terminals corresponding to both strings of HP heaters out of operation, under rated steam conditions, at a specified ambient temperature and 3% make up.

NOTE: While conducting the tests of (a) above the condenser pressure measurement shall be done at 300mm downstream of low pressure turbine last stage bottom blade tip.

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3.03.03 **TURBINE AUXILIARIES**

(i) **H.P./L.P. BYPASS CONTROL**

The HP & LP Bypass system should satisfy the following functional requirements under automatic interlock action. It should come into operation automatically under the following conditions:

(a) Generator circuit breaker opening.

(b) HP - IP stop valves closing due to turbine tripping.

(c) Sudden reduction in demand to house load.

Under all these conditions, while passing the required steam flows as per the relevant heat balances, the condenser should be able to swallow the entire steam without increasing the exhaust hood temperature and condenser pressure beyond the maximum permissible value indicated by the BIDDER in his offer and accepted by the EMPLOYER. The same shall be demonstrated.

(ii) **STEAM CONDENSATE PARAMETERS**

(a) Temperature of condensate, at outlet of condenser, shall not be less than saturation temperature corresponding to the condenser pressure at all loads.

(b) Oxygen content in condensate, at condensate collection tank outlet, shall not exceed 0.015 CC per litre over the entire load range and shall be determined according to calorimetric Indigo - Carmine method.

(c) Air leakage in the condenser under full load condition shall not exceed more than 50% of design value taken for sizing the condenser air evacuation system.

(e) The capacity of each vacuum pump in free dry air under standard conditions at a condenser pressure of 25.4 mm Hg (abs) and sub cooled to 4.17 deg.C below the temperature corresponding to absolute suction pressure shall not be less than as specified elsewhere. Correction curves for establishing the capacity at site conditions shall also be furnished.

(f) The air and vapour mixture from air cooling zone of condenser shall be 4.17 deg.C below the saturation temperature corresponding to 25.4 mm Hg (abs) suction pressure. Correction curves for establishing the same at site conditions shall also be furnished.

(iii) **FEED WATER HEATERS & DEAERATORS**

(a) TTD's and DCA's of feed water heaters in line with 800 MW heat rate guarantee heat balance shall be demonstrated.

(b) Dissolved O2 content in Deaerator effluent at deaerator outlet without chemical dosing at all loads, not to exceed 0.005 CC/ litre determined as per D5543-09 Indigo Carmine method.

(c) Difference between saturation temperature of steam entering the deaerator and temperature of feed water leaving deaerator.

(iv) **C□□d□□□□□□ Ex□r□□□□□□ P□□ □□**

(a) Each CEP set shall be capable of delivering flow & total dynamic head corresponding to runout point as specified.

(b) The vibration, noise level and parallel operation of any two of the three pumps shall be demonstrated.

(v) **Dr□□ P□□ □□ (□□□□□□□□□□d)**

(a) Each drip pump shall be capable of delivering flow & total dynamic head corresponding to design point as specified.

(b) The vibration and noise level shall be demonstrated.

(vi) **B□□□r □□d □□□ □□**

(a) Each boiler feed pump set shall be capable to deliver flow and total dynamic head corresponding to runout point as specified elsewhere.

(b) The vibration, noise level and parallel operation of any two of the three pumps shall be demonstrated as per specification requirements.

(c) Cold start up / hot start up of the unit using TDBFP with motive steam from auxiliary steam header.

3.03.04 **B□□□□□□ P□□ □□□B□□□ □r□□F□□□□C□□ □r□□□□□r□ □□d r□□□□□□ □□□□□□ □□□.**

a) The vibration, noise level and parallel operation, wherever applicable, of the pumps, blowers, fans, compressors and rotating equipment shall be demonstrated.

b) Pumps, blowers, fans, compressors and rotating equipment shall be capable of delivering flow and head corresponding to design point as specified.

3.03.05 **B□□□□□□□ □□C□□/Pr□□ □r□ □r □□□**

Contractor shall balance the primary air as well as coal flows in the pulverised fuel pipes such that the minimum PF and PA flow imbalance in the PF pipes from each coal pulveriser does not exceed 5% of average flows.

The above balancing shall be checked by the Contractor by carrying out both clean air test and dirty air test (using dirty pitot tubes).

3.03.06 **D□□ □□□□r□□□□ □□ □□□□r □□□r□□□□□r□□□ □□ □□□□□□□ □□ □□d □□d □□dd□□ □□d □□□□□□ □ □□□□□□d □□□□□□□□**

Refer Sub section-A-02 and A-03 ,Part-B(Mechanical), Section VI of Technical Specification..

3.03.07 **S□□□□ T□□ □□r□□□r□ l□ □□□□□□□**

The Contractor shall demonstrate that at SH and RH outlets (in case of more than one outlet) the temperature imbalance between the outlets does not exceed 10 deg C under all loads including transients.

3.03.08 **N□ □□□□□□□□□□□□r□□□□□□□□ r□□□□r□d □□□□□ 40% BMCR**

Contractor shall demonstrate that oil support for flame stabilization shall not be required beyond 40% of BMCR load when firing the coals from the range identified. The Contractor

shall demonstrate that with any combination of mills/ adjacent mills in service (to Employer's choice) the Steam Generator does not require any oil firing for stable and efficient boiler operation at and above 40% BMCR loads.

3.03.09 **C□□□□□□□□□□□ □□□□□dr□□□□**

After completion of installation of drives, contractor shall demonstrate the capability of all drives as specified elsewhere in Section VI Part B of Technical Specifications.

3.03.10 **M□r□□□ □□ F□□□**

After completion of installation of fan drives, Fans, inlet and outlet ducting, measuring equipments etc. contractor shall demonstrate the margin on seal air fans, primary fans, Forced draft fans and induced draft fans as specified elsewhere in Section VI Part B of Technical Specifications.

3.03.11 **C□d A□r V□□□□□□ T□□□(CAVT)**

A CAVT shall be conducted on each Steam Generator during commissioning before its initial operation to establish the average cold air velocity and the velocity distribution at minimum three predetermined sections (Employer's Choice) of steam generator. The data obtained from the CAVT will be used to compute the actual flue gas velocities as well as their distribution at the test sections during actual operation by correlating the CAVT data with the test/computed data from Thermal Performance Test as per Clauses 1.03.04 (iii) sub section-IV, Section-VI- Part-A. Should the CAVT results after this correlation with TPT data indicate actual localized high flue gas velocity zones/ mal-distribution of gas flow and/or flue gas laning, suitably designed stainless steel screens at required SG cross sections shall be provided by the Contractor to bring the deviation of the localized gas velocity within ± 20% of average gas velocity specified. Through this test the Contractor shall also demonstrate the compliance with the specification requirements regarding the maximum allowable flue gas velocities at various sections of the Steam Generator, refer sub-sectdion-A-03, Part-B of Technical Specifications.

The detailed CAVT procedure shall be to Employer's approved. The Contractor shall submit a detailed CAVT report and the computations of actual velocities after correlating CAVT data with TPT data to the Employer for approval.

3.03.12 **C□□□□□□□□□□□ □□□□r□□□ □□30% □□ □□r□□d □□□□**

Contractor shall demonstrate the capability of Steam generator and its auxiliaries to operate at rated parameters safely and on sustained basis at TMCR load while firing range of Indian coal(s) as specified in Table-1(A), Annexure-IV-2 ,sub section-IB ,Part-A of Section-VI blended with imported coal up o 30% by weight specified in Table-4, Annexure-IV-4, sub section-IB ,Part-A, Section-VI. Such demonstration shall be for 72 hours of continuous operation

3.03.12 a) Performance characteristic of fans (PA/FD/ID fan capacity, head developed, etc.)

3.03.13 Passenger & good elevators for steam generator – overload tests, travel and hoist speed checks.

3.03.14 Auxiliary Boiler Rating

Contractor shall demonstrate the rated parameters of Auxiliary Boiler, its steam generating capacity as per Clause 1.05.20 of Sub-section A-02.

3.03.15 ESP Air in Leakage

Contractor shall demonstrate that ESP air in leakage shall be limited to 1% of the total gas flow under guarantee point condition.

3.03.16 Pressure Drop Across ESP

Contractor shall demonstrate that the maximum flue gas pressure drop across the ESP under specified guarantee point condition shall not exceed 20 mmwc.

3.03.17 FGD System

(i) Performance characteristics of fans (capacity, head developed, etc.) and margins on fans in case Booster Fan, as specified in Part-B of technical specification,is provided by the Contractor.

(ii) Capabilities of all drives (Refer Part B of Technical Specifications)

(iii) Passenger cum Goods Elevator for FGD absorber & Limestone Grinding Building: Over load tests, travel and hoist speed checks.

3.03.17 Hydrogen Generation Plant

a) Parallel operation of two streams shall be demonstrated at site. Purity level and moisture contents of Hydrogen shall also be demonstrated at site.

b) Hydrogen Generation Plant capacity of each stream shall be demonstrated at site.

3.04.00 **Pr□-□□□ □ □□□□□□□□ & C□□ □ □□□□□□□□ □□□□□□□□ r□□□r□□□ □□□r□□□□□□□□ □□ □□□□r:**

(a) Hydraulic Test for STG integral piping, heat exchangers, condenser tubes & condenser, equipment cooling water system pipes and associated equipment etc. shall be done. The hydraulic test of other piping system as per statutory requirement and specified elsewhere shall also be carried out. All equipment needed for the tests shall be furnished by the Contractor.

(b) Oil flushing of lube oil system, control & jacking oil system, etc. for turbines shall be done. Entire flushing oil requirement & refilling with fresh oil and other consumables along with flushing equipment shall be met by the Contractor.

(c) High Pressure/Low Pressure (HP/LP) bypass tests, vacuum tightness test as per approved procedures shall be done by the Contractor after arranging & lining up of all the necessary equipment by him.

(d) Steam blowing & chemical cleaning, as applicable of integral piping of the turbo-generator, Low pressure piping, Power cycle piping & other piping in the scope of the Contractor shall be done by the Contractor.

(e) Steam blowing & chemical cleaning, as applicable of integral piping of CEP sets & other piping in the scope of the Contractor shall be done by the Contractor.

(f) All tests and activities pertaining to the CEP and its drive as per manufacturer's recommendations and as given in the chapter and covered in the specification.

(g) Steam blowing & chemical cleaning, as applicable of integral piping of Drip Pump sets & other piping (if applicable) shall be done by the Contractor.

(h) All tests and activities pertaining to the Drip Pump and its drive (if applicable) as per manufacturer's recommendations and as given in the chapter and covered in the specification.

(i) Steam blowing & chemical cleaning, as applicable of integral piping of the Heaters & other components shall be done by the Contractor.

(j) All tests and activities pertaining to the Heater as per manufacturer's recommendations and as given in the chapter and covered in the specification.

(k) Oil flushing of lube oil system, control & jacking oil system, for BFP sets shall be done. Entire flushing oil requirement & refilling with fresh oil and other consumables along with flushing equipment shall be met by the Contractor.

(l) Steam blowing & chemical cleaning, as applicable of integral piping of BFP sets & other piping shall be done by the Contractor.

(m) All tests and activities pertaining to the BFP and its drive as per manufacturer's recommendations and as given in the chapter and covered in the specification.

(n) Hydraulic Test for all low and high pressure piping, equipment cooling water system pipes and associated equipment etc. shall be done as per statutory requirement and specified elsewhere shall be carried out. All equipment needed for the tests shall be furnished by the Contractor.

(o) All tests and activities pertaining to the Generator and Excitation as per manufacturer's recommendations and covered in the specification.

(p) All tests and activities pertaining to the Generator Auxiliaries viz Primary water system, Seal oil system, Gas system etc., as per manufacturer's recommendations and covered in the specification.

(q) Any other pre-commissioning checks/ tests and activities as described below and also those mutually agreed between the Contractor & the Employer shall be undertaken.

3.05.00 COMMISSIONING OF FACILITIES

G□□□r□□

Upon completion of pre-commissioning activities/test the Contractor shall initiate commissioning of facilities. During commissioning the Contractor shall carryout system checking and reliability trials on various parts of the facilities.

Contractor shall carry out these checks/tests at site to prove to the Employer that each equipment of the supply complies with requirements stipulated and is installed in accordance with requirements specified. Before the plant is put into initial operation the Contractor shall be required to conduct test to demonstrate to the Employer that each item of the plant is capable of correctly performing the functions for which it was specified and its performance, parameters etc. are as per the specified/approved values. These tests may be conducted concurrently with those required under commissioning sequence.

The Contractor shall finalize the protocol of check lists, after erection of the system and equipment, as per International Codes/Standard with the Employer.

The Contractor shall furnish requisite no. of copies of procedures and list of start up, pre-commissioning, commissioning and initial operation tests for Employer's approval.

The Contractor shall also demonstrate the performance of all C&I equipment, the tests on main equipment or prior to that as the case may be.

Other tests shall be conducted, if required by the Employer, to establish that the plant equipments are in accordance with requirements of the specifications.

3.05.01 The Commissioning tests/checks shall specifically include but will not be limited to following:

(a) Checks on the operation of all controls of isolating gas and air dampers.

(b) Checks on operation of all fans and all rotating equipment to ascertain level of noise and vibration.

(c) Test running of all pumps.

(d) Checks on operation of all air heaters and adjustment of seals, if necessary when each heater is upto its working temperature.

(e) Checks on operation of all soot blowers and retraction gear and the sequences control.

(f) Check run on the Pulverised Fuel (P.F.) Mills including clean air flow test.

(g) Standard commissioning tests and procedures as per Contractor's practice for Steam Generator, SCR System, FGD System and other equipment / auxiliaries.

(h) Checks on operation of all individual control loops in the Steam Generator control loops in the Steam Generator control system including SCR & FGD System.

(i) Checks on inter-relation between each control loop in the Steam Generator control system including SCR & FGD system. Checks on inter-relation between each control loop in the turbine generator control system.

(j) Checks on correct functioning of the Burner Management System (BMS).

(k) Calibration tests of orifice, flow nozzles, instruments and control equipment to the extent included in these specifications.

(l) Tests on Control & Instrumentation (C&I) Equipments:

3.05.02 **LIST OF TEST / ACTIVITIES TO BE PERFORMED ON TG & AUXILIARY (□□□□□□□□ □□d □□ □□□□□ □□□)**

A) COMMISSIONING TESTS/CHECKS

1. Test running of all pumps

2. Condenser vacuum test, feed water heater operational tests for establishing correct cascaded flow, heater water levels etc. & checking of all parameters as per approved heat balance diagrams.

3. Test for HP/LP bypass valves operation & their control system.

4. Test for operation of governing control system for turbines.

5. Standard commissioning tests and procedures as per Contractor's practice for steam turbine generator and other equipment / auxiliaries within the Contractor's scope of work.

6. Checks on operation of all individual control loops in the turbine generator control system.

7. Checks on correct functioning of the Turbine Protection System (TPS), Turbine Supervisory Control System (TSCS) for main turbine, Automatic Turbine Run-up System (ATRS), Automatic Testing of Turbine (ATT).

8. Standard commissioning tests and procedures as per Contractor's practice for CEP and other equipment / auxiliaries within the Contractor's scope of work.

9. Checks on operation of all individual control loops in the CEP control system.

10. Standard commissioning tests and procedures as per Contractor's practice for Drip Pump (if applicable) and other equipment / auxiliaries within the Contractor's scope of work.

11. Checks on operation of all individual control loops in the Drip Pump control (if applicable) system.

12. Feed water heater operational test for establishing correct cascaded flow, heater water levels and checking of all parameters as per approved heat balance diagram.

13. standard commissioning tests and procedures as per contractor's practice for heaters and de-aerator and other equipment/auxiliaries within the contractor's scope of work.

14. Checks on operation of all individual control loops in the heater and deaerator control system.

15. Test for operation of governing control system for BFP turbines.

16. Standard commissioning tests and procedures as per Contractor's practice for BFP and other equipment / auxiliaries within the Contractor's scope of work.

17. Checks on operation of all individual control loops in the BFP control system.

18. Checks on correct functioning of the BFP Turbine for Turbine Protection System (TPS), Turbine Supervisory Control System (TSCS) for main turbine, Automatic Turbine Run-up System (ATRS), Automatic Testing of Turbine (ATT).

19. Calibration tests of orifice, flow nozzles, instruments and control equipment to the extent included in these specifications.

20. Checks on operation of all rotating equipments to ascertain level of noise and vibration

21. Checks on operation of all static equipments to ascertain level of noise and vibration

22. Standard commissioning tests and procedures as per manufacturer's practice for Generator, Excitation and its auxiliaries within the Contractor's scope of work.

3.06.00	**B□□□□□□ □□P□□□□□□□□□□ □□□& □□□□□□ □**
	All pre-commissioning tests &activities as required for successful running of the equipment or as mentioned in the technical specification elsewhere shall be performed by the contractor.
4.00.00	**INITIAL OPERATION**
	Upon completion of system checking/tests and as a part of commissioning of facilities, complete plant/facilities shall be put on initial operation for a period of thirty (30) days or 720 hours as stipulated in General Technical Requirements.
5.00.00	The Contractor shall conduct all the commissioning tests and undertake commissioning activities pertaining to all other auxiliaries and equipments including all Electrical & C&I equipment/systems not specifically brought out above but are within the scope of work and facilities being supplied & installed by the Contractor and follow the guidelines indicated above or elsewhere in these technical specifications (Section-VI).
6.00.00	The Contractor shall conduct the comprehensive guarantee tests on the Steam Generator in co-ordination with the Steam Generator to establish the functional guarantee values at stipulated conditions as per Sub-section-IV, Part-A, Section-VI.
7.00.00	The Contractor shall conduct all the commissioning tests and undertake commissioning activities pertaining to all other auxiliaries and equipments including all Electrical & C&I equipment/systems not specifically brought out above but are within the scope of work and facilities being supplied & installed by the Contractor and follow the guidelines indicated above or elsewhere in these technical specifications (Section-VI).
8.00.00	**COMMISSIONING SPARES**
8.01.00	It will be the responsibility of the Contractor to provide all commissioning spares including consumable spares required for initial operation till the Completion of Facilities. The Contractor shall furnish a list of all commissioning spares within 60 days from the date of Notification of Award and such list shall be reviewed by the Employer and mutually agreed to. However, such review and agreement will not absolve the Contractor of his responsibilities to supply all commissioning spares so that initial operation do not suffer for want of commissioning spares. All commissioning spares shall be deemed to be included in the scope of the Contract at no extra cost to the Employer.
8.02.00	These spare will be received and stored by the Contractor at least 3 months prior to the schedule date of commencement of initial operation of the respective equipment and utilized as and when required. The unutilized spares and replaced parts, if any, at the end of successful completion of guarantee tests shall be the property of the Contractor and he will be allowed to take these parts back at his own cost with the permission of Employer.

ANNEXURE-I

STANDARD CHEC□LIST

This is an indicative list of items. The actual list shall depend on the Equipment / System being supplied by the contractor.

MECHANICAL

VALVES

1. Manually Operated Valve
2. Electrically Operated Valve
3. Pneumatically Actuated Valve
4. Hydraulically Actuated Valve
5. Safety Valve
6. Electromatic Relief Valve
7. Steam Trap
8. Non Return Valve (including Hydraulic/ Pneumatic QCNRVS)
9. Control Valve
10. Relief Valve
11. Differential Pressure Regulating Valve
12. Butterfly valve (Electrically Operated)
13. Butterfly valve (Manually Operated)
14. Butterfly valve (Fourway -Electrical)
15. One spare EOTV for steam blowing

TAN□S & PRESSURE VESSELS

1. Tanks (metal) up to 20 M^3
2. Tanks (Large Storage)
3. Pressure Vessel (Below 17 bars)
4. Air Receiver
5. Pressure Vessel – Access Door

PUMPS

1. Pump-Low Pressure Centrifugal (Motor driven)
2. Pump-Up to 350HP
3. Pump-Sump installation
4. Gear Pump/Screw pump
5. Slurry Pumps
6. Vacuum Pumps

PIPE WOR□ SYSTEM

1. Steam services

2. Water services
3. Slurry Services
4. Oil / Fire Resistant fluid system
5. Air services (Compressor)
6. High pressure services
7. Constant load support
8. Spring supports
9. PF Coal
10. Hangers and other Supports

STRAINER AND FILTER

1. Strainer / Filter Basket Type
2. Strainer Rotary (Low Pressure)
3. Filter & Strainers Centrifugal Separators
4. Filter & Strainer Y-Type
5. Filter & Strainer (Plate Type)
6. Purifier
7. Filter – Compressed Air Line

HEAT EXCHANGER

1. Heat Exchanger (General)
2. Heat Exchanger – Oil / Water
3. Rotary Air Heater

FANS & COMPRESSORS

1. Fans –Non-Pressure Lubricated
2. Fans – Axial Flow pressure Lubricated
3. Compressors-General including H2 gas compressor
4. Blowers

DAMPERS & GATES

1. Manually Operated Damper
2. Pneumatically Operated Damper
3. Electrically Operated Damper
4. Manually Operated Gates
5. Pneumatically Operated Gate
6. Electrically Operated Gate

DUCT WOR□

1. Air & Flue Gas Ducting
2. Expansion Joints
3. Observation & Access Door

CRANES AND ELEVATORS

1. Auxiliary Overhead Crane
2. Travel Support Structure for Crane
3. Long Travel & Cross Traverse Motion of Crane
4. Main Aux. Hoist Motion (Crane)
5. Crane Electric Hoist
6. Passenger cum goods elevator

POWER TRANSMISSION

1. Power Transmission Gear Box
2. Bearings
3. Fluid Couplings

BOILER & AUX.SYSTEM

1. Soot Blower Long Retractable
2. Wall Deslagger/Soot Blower
3. Bottom Ash Hopper
4. Fly Ash Hopper
5. Lubricator –Compressed Air Lines
6. Wind Box Assembly
7. Mixer / Stirrer
8. Compressed Air Breathing Apparatus
9. Oil Burner
10. Ignitors
11. Scanner
12. Manual Lubricators
13. Air Motor
14. Driers-Non Regenerative /Regenerative
15. Coal Bunker

FGD & AUX.SYSTEM

1. Agitators
2. Air Motor
3. Process trestle
4. Limestone feeder
5. Vacuum belt filter

6. Limestone ball mill
7. Limestone Hydrocyclones
8. Primary Hydrocyclones
9. Secondary Hydrocyclones
10. Absorber internals
11. Absorber Auxiliaries

ELELCTRICAL

1. D.C. Motor
2. HV Squirrel Cage Induction Motor
3. 415 V Squirrel Cage Induction Motor
4. Motor Operated Actuators
5. Soot Blower (Deslagger)
6. Soot Blower (Long Retractable)
7. Soot Blower (Air Heater)
8. Aux. Control and Relay Panel Desk
9. LT SWITCHGEARS/MCC
   - a) STANDARD CHECLISTS FOR ALL TYPES OF RELAYS USED IN SWITCHGEARS PROTECTION SYSTEM
   - B) PT CARRIAGE AND CUBICLES
   - C) CABLE/BUS DUCT/BUS BARS
   - D) CONTRACTOR MODULE
   - E) SWITCH FUSE MODULE
   - F) MASTER PANEL OF LUBE OIL PANEL
   - G) FEEDER PANEL OF LUBE OIL PANEL
   - H) SPACE HEATER AND CABLE MODULE
   - I) HT CIRCUIT BREAKER
   - J) 415 V CIRCUIT BREAKER
   - K) POWER CABLE
   - L) AUXILIARY CABLE
   - M) D.C. CABLE
   - N) EXPLOSION PROOF ELECTRICAL EQUIPMENT
   - O) JUNCTION BOX
   - P) CONTROL TRANSFORMER MODULE
   - Q) BRUSH GEAR ASSEMBLY
   - R) AUX. CONTROL AND RELAY PANEL DESK
   - S) INDICATING INSTRUMENT
   - T) RECORDING INSTRUMENT
   - u) INTEGRATING INSTRUMENT

CONTROL & INSTRUMENTATION

1. Conductivity Measuring Equipment Including Test Procedures
2. pH Analyser Including Test procedure

3. Silica Analyser
4. Level Switch (Float Actuated)
5. Level Switch (Electrode Type)
6. Level Switch (Displacer Actuated)
7. Transmitter (Float Operated Pneumatic Output including Testing procedures
8. Level indicator (Float/Pulley Type)
9. Local Temperature Indicator Including Test Procedure
10. Resistance Thermometer Element Including Test procedure
11. Thermocouple Element and Connecting Cable
12. Thermocouple and Resistance Thermometer Convertor/Transmitter Including Test Procedures
13. Temperature Switch Including Test Procedure
14. Cold Junction Boxes
15. 0_2Analyser
16. 0_2 in Hydrogen including Test procedures
17. Pressure and Vacuum Gauge
18. Pressure and Vacuum Switch Including Test procedures
19. Differential Pressure Transmitter including Test Procedures
20. Differential pressure switch including Test procedures
21. Flow indicator (Variable Area)
22. Orifice plate
23. Flow Switch
24. Nozzle
25. Flow Integrator (pneumatic input) including test procedure
26. Flow indicator (Float Operated) Including Test Procedure
27. Venturi (Fluid)
28. Flow Switch (Magnetic Type)
29. Limit Switches
30. Turbine Supervisory Measuring System
31. Position Measurement & Indication Including Test procedures
32. Vibration Measurement
33. Digital Indicator
34. Moving Coil Indicator Including Test Procedures
35. Recorder Including Test procedure
36. Flame Scanner
37. Electrical Auto Manual Control Station
38. Push Button Module

39. Test Procedure for Electronic Modules of DDCMIS
40. Alarm Annunciator Equipment Including Test Procedure
41. Test procedure for Adjustment of Modulating Controller-PID Term
42. Test Procedure Indicating Controller-Electrical Input & Pneumatic Output

ANNEXURE-II

TESTING / COMMISSIONING PROCEDURES

Following is an indicative list of equipments / systems for which Testing / Commissioning procedures are to be submitted. The actual list will depend on the equipment / system being supplied by the Contractor.

S. N□	DESCRIPTION
	B□□□r
1.	ID Fan
2.	FD Fan
3.	PA Fan
4.	Air Heater
5.	Scanner Air Fans
6.	Fuel Firing System
7.	Milling System
8.	Soot Blower System
9.	Aux. Steam System
10.	Mill Reject Handling System
11.	HP Bypass System
12.	S.A.D.C. and its control
13.	Boiler Chemical Analysis Equipment
14.	SH / RH Spray system
15.	Chemical Dosing System
16.	Boiler Air and Gas System -Interlock Operation
17.	Boiler Start-up Re-Circulation Pump
18.	Coal Feeders
19.	Electrostatic Precipitator

20.	Dosing System
21.	Seal Air Fans
22.	Boiler Safety Valves
FGD S□□□□	
1.	Booster Fan (if provided)
2.	Absorber System
3.	Limestone grinding system
4.	Absorber system
5.	Gypsum dewatering system

LIST OF TEST / ACTIVITIES TO BE PERFORMED ON TG & AUXILIARY

(BUT NOT LIMITED TO THE FOLLOWING)

A) **TESTING SCHEDULES**

1. TURBINE ON BARRING GEAR
2. BEARING AND JACKING OIL INITIAL CIRCULATION
3. HP BYPASS SYSTEM
4. LP BYPASS SYSTEM
5. GOVERNOR OIL CONTROL SYSTEM
6. VACUUM RAISING PLANT
7. CENTRAL OIL PURIFICATION PLANT

. HYDRAULIC TEST PROCEUDRE FOR

A) LUB OIL SYSTEM

B) CONTROL OIL & JACKING OIL SYSTEM

C) GENERATOR SEAL OIL SYSTEM

D) GENERATOR STATOR WATER SYSTEM

E) GENERATOR GAS SYSTEM (Alternatively, pneumatic test with suitable leak detection method shall also be acceptable subject to owner's approval)

F) HEATERS

9. OIL FLUSHING OF LUB OIL SYSTEM
10. OIL FLUSHING OF CONTROL & JACKING OIL SYSTEM
11. OIL FLUSHING OF GENERATOR SEAL OIL SYSTEM
12. ALKALI FLUSHING FOR CONDENSATE SYSTEM
13. HP/ LP BYPASS SYSTEM
14. CONDENSER VACUUM TIGHTNESS TEST
15. STEAM BLOWING OF GLAND SEAL PIPE LINES, AUX. STEAM PIPELINE
16. CEP
17. Drip Pump (if applicable)
18. HEATER
19. DEAERATOR
20. BFP
21. BEARING AND JACKING OIL INITIAL CIRCULATION
22. GOVERNOR OIL CONTROL SYSTEM
23. HYDRAULIC TEST PROCEDURE FOR
    - A) LUB OIL SYSTEM
    - B) CONTROL OIL & JACKING OIL SYSTEM
    - C) WATER SYSTEM
    - D) HEAT EXCHANGERS
24. OIL FLUSHING OF LUB OIL SYSTEM
25. OIL FLUSHING OF CONTROL & JACKING OIL SYSTEM
26. STEAM BLOWING OF GLAND SEAL PIPE LINES, AUX. STEAM PIPELINE
27 HT MOTORS

B) COMMISSIONING SCHEDULE

1. Turbine Gland sealing system for Main Turbine
2. HP-LP Bypass system
3. Turbine Initial Run up for Main Turbine

4. Lube Oil / Governing Oil System for Main Turbine
5. LP HEATERS
6. HP HEATERS
7. DEAERATOR STEAM OPERATION
8. Turbine Gland sealing system for BFP turbine
9. Turbine Initial Run up for BFP turbine
10. Lube Oil / Governing Oil System for BFP turbine
11. Generator and excitation system
12. Generator seal oil system
13. Generator stator water system
14. Generator gas system

Other Systems	
1.	Compressed Air System
2.	Hydrogen Generation/ Bottling Plant
3.	Fire Protection & Detection System
4.	Air Conditioning and Ventilation System
5.	Ash Handling System • Bottom Ash System • Coarse Ash System(Economiser Ash) • Fly Ash System (ESP and APH) • Ash Slurry Disposal System • Ash water System
6.	Fuel Oil Pressurizing System

ANNEXURE-III

COMMISSIONING PROCEDURES RE□UIRING APPROVAL OF EMPLOYER

S.NO.	DESCRIPTION
1.	BOILER HYDRAULIC TEST & PRESERVATION
2.	OIL FLUSHING OF LUB OIL SYSTEM OF ROTARY EQUIPMENTS
3.	DETERGENT FLUSHING OF PRE-BOILER AND CONDENSATE SYSTEMS
4.	AIR & GAS TIGHTNESS TEST FOR FURNACE AND DUCTS
5.	AIR IN LEAK TEST OF ESP
6.	AIR & GAS TIGHTNESS TEST FOR FGD
7.	LIMESTONE GRINDING SYSTEM
8.	GYPSUM DEWATERING SYSTEM
9.	CHEMICAL CLEANING OF BOILER
10.	STEAM BLOWING & OIL FLUSHING OF FUEL OIL LINES
11.	STEAM BLOWING OF BOILER, ASSOCIATED STEAM LINES & AUX STEAM LINES
12.	GD TEST OF ESP
10	CLEAN AIR FLOW TEST OF MILLS
11	FLUSHING & HYDRAULIC TEST OF TG LUB OIL & JACKING OIL SYSTEMS
12	FLUSHING & HYDRAULIC TEST OF CONTROL FLUID SYSTEM
13	OIL FLUSHING OF LUB OIL SYSTEM OF MDBFP
14	COMMISSIONING OF HP BYPASS SYSTEM
15	COMMISSIONING OF LP BYPASS SYSTEM
16	FLUSHING & HYDRAULIC TEST OF GENERATOR SEAL OIL SYSTEM
17	FLUSHING & HYDRAULIC TEST OF GENERATOR PW SYSTEM
18	GENERATOR AIR TIGHTNESS TEST
19	VACUUM TIGHTNESS TEST
20	GENERATOR TESTING PROCEDURE FOR 1ST SYNCHRONISATION

ANNEXURE-IV

Demons □ration /**A**ccept □nce □ests **d**u**r**ing **C**ommission □ng/**I**nitial **O**pe**r**ation

The following tests shall be demonstrated during commissioning for which the bidder has to furnish the procedure and get the approval of the employer:

1. Start-up, Loading, Unloading and Shutdown Capabilities (For Turbine Generator)
2. Turbine Generator Set Capability
3. Turbine Auxiliaries
4. Balance Pumps, Blowers, Fans, Compressors and rotating equipment.
5. Balancing of Coal/Primary air flow
6. Demonstration of boiler operation, rate of change of load and sudden load change withstand capability
7. Steam Temperature Imbalance
8. No fuel oil support shall be required above 40% BMCR
9. Capability of all drives
10. Margin on Fans
11. Cold Air Velocity Test (CAVT)

ANNEXURE-V

BRIEF WRITE UP ON THE CONTENTS OF TESTING / COMMISSIONING PROCEDURE

Testing / Commissioning Procedure is required to be of a standard format in order to maintain consistency of presentation, content and reporting. These should contain the following sections to make the document a self contained one.

1. Plant Details / Design data
2. Objective
3. Proposal
4. Services Required
5. Safety Precautions
6. Emergency Procedures
7. State of the Plant (Status in respect of erection completion of Mech, Elect and C&I items)
8. Method
9. Completion / Acceptance Criteria
10. Appendix
    - Result
    - Log sheet
    - Drawing etc.

e-Learning Package For Pre Treatment Plant

e-Learning Package:

e-learning packages shall be supplied for the equipment / system for the complete Pre Treatment Plant along with associated electrical and C&I system.

These packages shall be installed on the Learning Management Server (LMS) of Power Management Institute (PMI) , NTPC located at Noida . The Engineer- In-Charge (EIC) for the e-learning modules shall be from PMI.

1. The objective of the e-Learning package consisting of courses for erection, commissioning, operation and maintenance of equipment / system as specified above is to facilitate the employees to have first hand information / requirement with respect to above activities for the supplied equipment / system .

2. The bidder shall submit e-learning courses each for erection, commissioning, operation and maintenance of each of the equipment / system supplied as above.

- **a.** The erection course(s) should include instructions on pre-checks, prerequisites, erection strategy, erection procedure etc.
- **b.** The commissioning course(s) should include instructions on pre-commissioning, commissioning, initial operation etc.
- **c.** The operation course(s) should include instructions on the permissive, interlocks, physical check ups, start up, shutdown and protections etc.
- **d.** The maintenance course(s) should include instructions on predictive, preventive, breakdown and overhauling.

Depth of coverage of above courses shall be as specified for **"Instruction Manuals"** in General Technical Requirement Part-C, Section-VI of technical specification. A literature on caution / safety while handling equipment / system for the above modules shall follow the description of the said equipment /system.

3. The e-Learning packages on equipment / system shall be installed by the vendor and shall be successfully test run in the presence of EIC or representative before acceptance by NTPC. The vendor will also give the master copy in form of Flash Drive/CD/DVD. The respective module for erection & commissioning shall be delivered and successfully test run at least three months before the scheduled start of the corresponding activity at site. The respective module for operation & maintenance shall be delivered and successfully test run at least three months before scheduled first synchronization of first unit.

4. e-Learning course broad requirements:

a. The courses shall be web based and mobile based Application type. It shall run on all possible versions of web browser like Internet Explorer, Google Chrome, Firefox etc. on Laptop/Desktop and shall be Smartphone/Tablet/Mobile responsive. The Mobile responsive courses shall run on Android, Windows Mobile, Blackberry, iOS etc.

b. The courses shall support liquid/fluid page layout so that the entire screen gets adjusted to PC, Laptop, Smartphone/Mobile, Tablet and any other display devices.

c. Course content text shall be in English language and be associated with a voiceover in English language with Indian accent.

d. Courses shall be SCORM (Sharable Content Object Reference Model) compliant, version 1.2 which is compatible with LMS at PMI.

e. Each course shall have every physical and functional detail of the equipment / system supplied.

f. Each of the e-Learning course shall be based on multiple web pages and mobile pages with multiple modules.

g. There shall be option for self-assessment test after every course. In case the user doesn't opt for self assessment test the user shall be able to go to the next course. There shall be no restriction in no. of times for repeating the assessments. All correct answers along with the answers marked by the users shall be displayed at the end of test/quiz.

h. If Java and Flash, as applicable are not available in the system to run the package, then there shall be a prompt message for updation of the same.

i. Each course shall have a self-running interactive content with navigation buttons containing forward, backward, pause, bookmark and menu options in the course window.

j. The course shall contain chapter titled 'Introduction/overview' that explains the purpose of the course.

k. The course content shall contain descriptive text shall be factual, specific, terse, clearly worded, and simply illustrative, so that the user can understand it.

l. The system shall provide the user with the ability to select the information with a Cursor.

m. The course menu should contain table of content linked to concerned pages. The user shall be given the capability to access all of the functions available on the system through a menu system. This shall consist of active buttons, which shall control a hierarchy of pull down/pop up menus. Menu shall appear quickly and exist only while a selection is being made. The user shall be given the capability to position the cursor or pointer on the menu item and use pointer device such as mouse to activate the function.

n. Every course shall contain the 3D design/drawing/exploded view/360^0 turn around view of the equipment/system, textual description of the equipment/system and its functionality with video (as applicable), animation and audio.

o. The users shall be able to control audio sound level associated with the courses.

p. Drawings / text in the courses shall be scalable (Zoom In/ Out).

q. The user shall have the capability to record a **bookmark** to mark displayed information for later recall, whenever he accesses the same course next time.

Notes:

1. e-learning Package of an equipment / system shall include e-learning courses for each of erection, commissioning, operation and maintenance of that equipment / system.
2. e-learning courses on erection, commissioning, operation and maintenance of an equipment / system shall include e-learning lessons/chapters/modules (as required) for erection, commissioning, operation and maintenance respectively of that equipment / system.
3. The vendor shall get the approval of one sample course from EIC before proceeding for further courses.

File Formats Supported by SPPID, SPI, SPEL & SP3D

July 16, 2014

PREPARED BY- NEHA BANSAL

BHEL-PEM/ IPDS

SMARTPLANT P&ID (SPPID)

The data import and export facilities of SmartPlant P&ID allow users to populate the system with relevant plant data, such as process data from process simulation databases based on Aspen Basic Engineering from Aspen Technologies, Inc. or equipment and line lists. The user can use to import a spreadsheet in a recognized format to either update data on existing items in the plant database or to create new items in the SmartPlant P&ID Stockpile to use for designing the P&ID.

Aspen Basic Engineering spreadsheets in either Microsoft Excel or XML format are supported. These spreadsheets include the Vessel Equipment List, Pump Equipment List, and Heat Exchanger equipment. During the import process, you can assign the stream and its associated engineering data to the pipe run.

For SmartPlant P&ID Engineering, importing from SmartSketch is not allowed.

Users can save drawings in different formats, including .pid for SmartPlant P&ID, .dwg and .dxf for AutoCAD, .dgn for MicroStation, and .pdf format. SPPID items reports can be saved in Excel worksheet format.

SMARTPLANT INSTRUMENTATION (SPI)

The SPI Import Utility provides inherent support of the following database platforms and database file formats:

- Oracle (only if you have selected Oracle as your current database platform during Setup)
- SQL Server (only if you have selected SQL Server as your current database platform during Setup)
- Sybase Adaptive Server Anywhere (only if you have selected Sybase Adaptive Server Anywhere as your current database platform during Setup)
- Microsoft Access
- .dbf files
- ASCII delimited files
- Excel worksheets
- Text files

For text files, the Import Utility uses Microsoft Text drivers (.txt and .csv files).

SmartPlant Instrumentation provides a PowerSoft Report (.psr) file viewer that enables user to retrieve, view, and manage files saved in the .psr format. Reports or specifications can be saved in .psr file format using Save As command.

SmartPlant Instrumentation also enables the users to import/export process datasheets for lines or instruments in .ipd (SmartPlant Instrumentation process data) format for use with the Process Data Editor. In this way, it allows an external party to modify the process data outside of SmartPlant Instrumentation. The .ipd format allows to include multiple tags in a single file.

SmartPlant Instrumentation supports saving specification datasheets in the following formats:

- .isf (only specs whose item type is Instrument)
- .psr (any single-tag spec, multi- tag spec, or a non-instrument spec)
- .xls (only specs whose item type is Instrument)

- External Editor (supplied with the SmartPlant Instrumentation software package)- Supports working with spec data saved in .isf format, allows to convert .psr files to .isf format, and import data from .isf files to SmartPlant Instrumentation.
- InfoMaker- Supports working with spec data saved in .psr format, does not allow to import data from .psr files. First need to convert .psr files to .isf format in External Editor.
- Excel- Supports working with spec data saved in .xls format, does not allow to import data from Excel files back to SmartPlant Instrumentation.

SMARTPLANT ELECTRICAL (SPEL)

The SPEL Import Manager allows to import data to SmartPlant Electrical from external data files and various database platforms, such as

- Microsoft Access
- Microsoft SQL Server
- Oracle
- Excel worksheets

Import Manager provides the import of electrical data, association data, select list items, and lookup table values.

SmartPlant Electrical supports the major commercial databases and outputs drawings in common CAD formats including SmartSketch, and generates reports in Microsoft Excel format (For creating a report in Excel, file format of the blank template is XLSM for Office 2007 and Office 2010, for Office 2003, the file format is XLS.) SmartPlant Schematics can be imported and exported to an AutoCAD or MicroStation document.

The ETAP- SmartPlant Electrical interface allows to import ETAP data to SmartPlant Electrical and export data to ETAP. When exporting data to ETAP user can publish single electrical analysis SLDs or a complete set of all the existing electrical analysis SLDs in one set. When retrieving ETAP data, user can retrieve a particular ETAP one-line diagram or publish all project data to SmartPlant Electrical.

SMARTPLANT 3D (SP3D)

External reference 3D models for importing in SP3D can be of the following nature:

- Smart 3D models published in ZVF and XML format.
- PDMS models published to RVM and ATT format.
- PDS model data
- Plain graphic file formats from other tools such as .dgn files.

User can import 3D model data in SP3D from XML files. The files are created in two ways—XML files generated using the PDS Model Data Exporter, or XML files that are written in XMpLant format. PDS Model Data Exporter exports PDS data into XML files in Intergraph Schema. XMpLant is an industry standard (ISO15926), neutral format that is used to import third-party software data.

PDS Model Data Exporter

- Creates XML data that is compatible with the Intergraph (Ingr) schema.
- Mapping files for Intergraph schema XMLs are written in Excel workbooks.
- The PDS Model Data Exporter utility is delivered separately from SmartPlant 3D.

XMpLant-formatted XML

- This XML corresponds with XMpLant schema.
- Mapping files for XMpLant schema XMLs are written in XML format.
- Also added XMPlant to bring PDMS data into SmartPlant 3D

SmartPlant 3D Model Data can be exported to SmartPlant Review files (ZVF, VUE and XML files) or CAD (SAT) files.

The file types for each SP3D drawing type are described in the following table.

Drawing Type	Target File Types
MicroStation	MicroStation (*.dgn)
Piping Isometric Drawings NOTES • For Piping Isometric Drawings, the name of the drawing document becomes the prefix for all of the files. For example, if the drawing document name is *My_Pipeline*, the saved file names become: *My_Pipeline.sha*, *My_Pipeline.pcf*, and so on. • For Piping Isometric Drawings, a file is created for each sheet in the drawing with [*drawing name*]_[*sheet name*] as the filename. For example, if the drawing *My_Pipeline* contains Sheet1 and Sheet2, two files will be saved with the names *My_Pipeline_Sheet1* and *My_Pipeline_Sheet2*.	Shape2DServer (*.sha) PCF file (*.pcf) Both (*.sha & *.pcf) All Files (*.*) - Includes all .sha and .pcf files, as well as all enabled supplementary files. MicroStation (*.dgn) AutoCAD (*.dxf) AutoCAD (*.dwg)
Spreadsheet Reports	Worksheets (*.xls)
Composed Drawings, Volume Drawings, and Orthographic Drawings by Query	Shape2DServer (*.sha) MicroStation (*.dgn) AutoCAD (*.dxf) AutoCAD (*.dwg)

SmartPlant Interop Publisher

SmartPlant Interop Publisher provides the ability to work with a wide range of datasets from Intergraph and non-Intergraph formats such as PDMS and XMpLant.

Different data sources can be:

- PDS
- PDMS
- Tekla
- AutoCAD
- MicroStation

Company Formats

Application	Graphic File	Data File	SmartPlant Interop Publisher License	Notes
Intergraph				
Smart 3D v2009.1 and above in an integrated environment	ZVF	XML	No	A license of SmartPlant Interop Publisher is not needed to reference this format in Smart 3D
Smart 3D v2009.1 and above in a non-integrated environment	VUE	XML	No	
Smart 3D Pre v2009.1	VUE	XML	No	
Smart 3D using SmartPlant Review Direct	VUE	MDB2	Yes	
PDS, FrameWorks® Plus	DRI, DGN	DRV, TAG	Yes	
ISOGEN® (IDF,PCF, POD)	IDF, PCF, POD	IDF, PCF	Yes	

CADWorx Equipment, CADWorx Plant, CADWorx Plant Professional	DWG	DRV	Yes	
AVEVA				
PDMS	RVM	ATT, DRV	Yes	
Autodesk				
AutoCAD v2011 and earlier	DXF, DWG	DRV	Yes	AutoCAD proxy-enabled objects are supported.
Bentley				
MicroStation J MicroStation V8 MicroStation V8i MicroStation XM AutoPlant PlantSpace i-model	DGN, PRP, DTM	DRV	Yes	Data limited to MicroStation level and tag information. Requires MicroStation. SmartPlant Interop Publisher supports data files containing smartsolids that were created or reformatted in MicroStation V8.

Industry-Standard Formats

Open Standards				
Industry Foundation Classes (IFC)	IFC	DRV	Yes	
XMpLant	XML	DRV	Yes	

CIS/2 (design model data from products such as SP3D, SDS/2, StruCAD, Tekla Structures, and ProSteel, among others)	STP	DRV	Yes	
Mechanical Applications				
Products exporting ACIS (such as SolidEdge, SolidWorks, Pro/Engineer)	SAT	N/A	Yes	Graphics only
Products exporting IGES; Smart 3D using SmartPlant Review Direct	IGES, IGS	N/A	Yes	Graphics only

Generic Formats

System	Format	Notes
BOCAD	CIS/2	SDNF exports can be converted into CIS/2 FrameWorks Plus.
SACS	CIS/2 or ACIS (SAT)	SDNF to CIS/2 Conversion via FrameWorks Plus. Export SAT directly from SACS
AutoPLANT, PlantSpace	AutoCAD, ISOGEN	
ANSYS Workbench	ACIS (SAT)	
SolidEdge, SolidWorks, AutoCAD Inventor, CREO Parametric (formerly Pro/Engineer), Siemens, Catia	ACIS (SAT)	

SmartPlant Spoolgen, SmartPlant Isometrics	ISOGEN	
JT Open	SAT	JT Open to SAT conversion by Theorem
Speedikon, Tribon M2 / M3	MicroStation	
ShipConstructor	AutoCAD	Graphics only

Notes:

- Smart 3D applications require a license of SmartPlant Interop Publisher for conversion and reference of all formats.
- Laser scanning applications require the SmartPlant Review Point Cloud module to support the display of laser data inside SmartPlant Review.
- For ACIS and IGES files, the DRV and MDB2 files generated by SmartPlant Interop Publisher during translation are created with empty label data. This can also apply to MicroStation V7 DGN files that do not have tag data.
- Smart 3D applications require a license of SmartPlant Interop Publisher for translation and reference of all foreign or third-party formats.
- Both SmartPlant Review and Smart 3D applications require licenses from Leica, Z+F or Quantapoint to display laser data.

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FORMAT FOR OPERATION AND MAINTENANCE MANUAL

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FORMAT FOR OPERATION AND MAINTENANCE MANUAL

Project name :
Project number :
Package Name :
PO reference :
Document number :
Revision number :

Sl.no. & Sections	Description	Tick (√)if included in Manual			Remarks
		Yes	No	Not Applicable	
1.	**Cover page**				
1.1	Project Name				
1.2	Customer/consultant Name				
1.3	Name of Package				
1.4	Supplier details with phone, FAX ,email address , Emergency Contact number				
1.5	Name and sign of prepared by , checked by & approved by				
1.6	Revision history with approval Details				
2.0	**Index**				
2.1	showing the sections & related page nos All the pages should be numbered section wise				
3.0	**Description of Plant/System**				
3.1	Description /write up of operating principle of system equipment/ associated sub-systems & accessories/controls system , operating conditions, performance parameters under normal , start up and special cases				
3.2	Equipment list and basic parameter with Tag numbers				
3.3	Data sheets approved by Customer/for information and catalogues provided by original manufacturer				
3.4	Associated other packages and Interface /terminal points				
3.5	P&ID & Process Diagrams				
3.6	GA Layout drawings, As-built drawings , Actual photograph of items/system (Drawings of A2 & bigger sizes are to be attached in the last)				
3.7	Single line/wiring diagrams				
3.8	Control philosophy /control write-ups				
4.0	**Commissioning Activities (if not covered in separate document i.e. erection manual, commissioning manual)**				
4.1	Pre-Commissioning Checks				
4.2	handling of items at site				
4.3	Storage at site				
4.4	Unpacking & Installation procedure				
5.0	**Operation Guidelines for plant personal/user/operator**				
5. 1	Interlock & Protection logic along with the limiting values of protection settings for the equipment along with brief philosophy behind the logic, drawings etc. to be provided.				

5. 2	Start up, normal operation and shut down procedure for equipments along with the associated systems in step by step mode. Valve sequence chart, step list, interlocks etc. with Equipment isolating procedures to be mentioned.				
5. 3	Do's & Don't of the equipments.				
5. 4	Safety precautions to be taken during normal operation. Safety symbols, Emergency instructions on total power failure condition/lubrication failure/any other condition				
5. 5	Parameters to be monitored with normal values and limiting values				
5. 6	Trouble shooting with causes and remedial measures				
5. 7	Routine operational checks, recommended logs & records				
5. 8	Changeover schedule if more than one auxiliary for the same purpose is given				
5. 9	Painting requirement and schedule				
5. 10	Inspection, repair , Testing and calibration procedures				
6.0	**Maintenance guidelines for plant personal**				
6.1	List of Special Tools and Tackles required for Overhaul/Trouble shooting including special testing equipment required for calibration etc.				
6.2	Stepwise dismantling and re-assembly procedure clearly specifying the tools to be used, checks to be made, records to be maintained, clearances etc. to be mentioned. Tolerances for fitment of various components to be given.				
6.3	Preventive Maintenance & Overhauling schedules linked with running hours/calendar period along with checks to be given				
6.4	Long term maintenance schedules especially for structural, foundations etc.				
6.5	Consumable list along with the estimated quantity required during commissioning, normal running and during maintenance like Preventive Maintenances and Overhaul. Storage/handling requirement of consumables/self-life.				
6.6	List of lubricants with their Indian equivalent, Lubrication Schedule, Quantity required for each equipment for complete replacement is to be given				
6.7	List of vendors & Sub-vendors with their latest addresses, service centres ,Telephone Nos., Fax Nos., Mobile Nos., e-mail IDs etc.				
6.8	List of mandatory and recommended spare parts list				
6.9	Tentative Lead time required for ordering of spares from the equipment supplier				
6.10	Guarantee and warranty clauses				
7.0	**Statutory and other specific requirements considerations.**				
8.0	**List of reference documents**				
9.0	**Binding as per requirement**				

#

SITE STORAGE AND PRESERVATION GUIDELINES

FOR

MECHNANICAL BOPs

(Doc No: PE-DC-SSG-A001 REV.00)

PROJECT ENGINEERING MANAGEMENT, POWER SECTOR

BHARAT HEAVY ELECTRICALS LIMITED-NOIDA

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1. SCOPE OF THE DOCUMENT

This guideline is prepared in intent to provide proper site storage and preservation of the Mechanical, Electrical and C & I items / equipment supplied under various bought out packages/items. This storage procedure shall be followed at different power plant sites by concerned agency for storage and preservation from the date of equipment received at site until the same are erected and handed over to the customer.

2. PURPOSE OF STORAGE & PRESERVATION

Many of the items may be required to be kept in stores for long period. It shall therefore be essential that proper methods of storage and preservation be applied so that items do not deteriorate, loose some of their properties and become unusable due to atmospheric conditions and biological elements.

3. MEASURES TO BE TAKEN FOR STORAGE, HANDLING & PRESERVATION

a) GENERAL STORAGE REQUIREMENTS

1. To the extent feasible, materials should be stored near the point of erection. The storage areas should have adequate unloading and handling facilities with adequate passage space for movement of material handling equipment such as cranes, fork lift trucks, etc. The storage of materials shall be properly planned to minimise time loss during retrieval of items required for erection.
2. The outdoor storage areas as well as semi-closed stores shall be provided with adequate drainage facilities to prevent water logging. Adequacy of these facilities shall be checked prior to monsoon.
3. The storage sheds shall be built in conformity with fire safety requirements. The stores shall be provided with adequate lights and fire extinguishers. ‘No smoking’ signs shall be placed at strategic locations. Safety precautions shall be strictly enforced.
4. Adequate lighting facility shall be provided in storage areas and storage sheds and security personnel positioned to ensure enforcement of security measures to prevent theft and loss of materials.
5. Adequate number of competent stores personnel and security staff shall be deployed to efficiently store and maintain the equipment / material.
7. The equipment shall be stored in an orderly manner, preserving their identification slips, tags and instruction booklets, etc., required during erection. The storage of materials shall be equipment-wise. Loose parts shall be stored in sheds on racks,

preserving the identification marks and tags in good condition. The group codes shall be displayed on the racks

6. At no time shall any materials be stored directly on ground. All materials shall be stored minimum 200 mm above the ground preferably on wooden sleepers

b) GENERAL PRESERVATION REQUIREMENTS

1. All special measures to prevent corrosion shall be taken like keeping material in dry condition, avoiding the equipment coming in contact with corrosive fluid like water, acid etc.
2. Materials which carry protective coating shall not be wrapped in paper, cloth, etc., as these are liable to absorb and retain moisture. The material shall be inspected and in case of signs of wear or damages to protective coating, that portion shall be cleaned with approved solution and coated with an approved protective paint. Complete record of all such observations and protective measures taken shall be maintained.
3. Generally equipment supplied at site are properly greased or rust protective oil is applied on machined/ fabricated components. However periodic inspection shall be carried out to ensure that protection offered is intact.
4. While handling the equipment, no dragging on the ground is permitted. Avoid using wire rope for lifting coated components. Use polyester slings (if possible) otherwise protective material (e.g. clothes, wood block etc.) should be used while handling the components with rope / slings
5. For Equipment supplied with finished paint, touch paint shall be done in case any surface paint gets peeled off during handling. Otherwise such surfaces shall necessarily be wrapped with polythene to avoid any corrosion. Further for equipment wherein finish coat is to be applied at site, site to ensure that equipment is received with primer coat applied.
6. It shall be ensured by periodic inspection that plastic inserts are intact in tapped holes, wherever applicable.
7. Pipes shall be blown with air periodically and it shall be ensured that there is no obstruction.
8. Silica gel or approved equivalent moisture absorbing material in small cotton bags shall be placed and tied at various points on the equipment, wherever necessary.
9. Heavy rotating parts in assembled conditions shall be periodically rotated to prevent corrosion/jamming due to prolonged storage.

10. All the electrical equipment such as motors, generators, etc. shall be tested for insulation resistance at least once in three months and a record of such measured insulation values shall be maintained.

11. Following preservatives/preservation methods can be used depending upon type of equipment

    a. Rust preventive fluid (RPF)

    b. Rust protective paints

    c. Tarpaulin covers, in case of outdoor storage

    d. De-oxy aluminate for weld-ments

c) GENERAL INSPECTION REQUIREMENTS

1. Period inspection of materials with specific reference to –

    - Ingress of moisture and corrosion damages.
    - Damage to protective coating.
    - Open ends in pipes, vessels and equipment -
        - In case any open ends are noticed, same shall be capped.

2. Any damages to equipment / materials.

    - In case of any damages, these shall be promptly notified and in all cases, the repairs / rectification shall be carried out.
    - Any items found damaged or not suitable as per project requirements shall be removed from site. If required to store temporarily, they shall be clearly marked and stored separately to prevent any inadvertent use.

4. TYPE OF STORAGE FOR VARIOUS EQUIPMENT

The types of storage are broadly classified under the following heads:

i **Closed storage with dry and dust free atmosphere**. (C)

The closed shed can be constructed by using cold-rolled / tubular components for structure and corrugated asbestos sheets / galvanised iron sheets for roofing. Brick walls / asbestos sheets can be used to cover all the sides. The floor of the shed can be finished with plain cement concrete suitably glazed. The shed shall be provided with proper ventilation and illumination.

ii **Semi-closed storage**. (S)

The semi closed shed can be constructed by using cold-rolled / tubular components for structure and corrugated / asbestos sheets for roofing. The floor shall be brick paved. If required a small portion of sides can be covered to protect components from rainwater splashing onto the components.

iii Open storage (O)

The open yard shall be levelled, well consolidated to achieve raised ground with the provision of feeder roads for crane approach along with access roads running all sides. One part of the open yard shall be stone pitched, levelled and consolidated with raised ground suitable for storing / stacking heavier and critical components with due space to handle them by cranes etc . Adequate number of sleepers, concrete block etc. to be provided to make raised platforms to stack critical materials.

A separate yard to be identified as “scrap yard” slightly away from main open yard to store wooden/steel scraps, which are to be disposed off. This is required to avoid mix up with regular components as well as to avoid fire hazard.

Some of the components, which are having both machined & un-machined surfaces and are bulky, shall be stored in open storage area on a raised ground and suitably covered with water proof / fire retardant tarpaulin.

The equipment listed below shall be stored and inspected as per requirement mentioned in the table below.

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
Raw material /mechanical items like pipes, plates, structure sections etc.)				
1.	Steel pipes (lined/unlined)	S	Damage , paint, corrosion, rubber lining peeling	Provide end cap
2.	MS Plates	S	Damage, paint, corrosion	
3.	SS Plates	S	Damage	
4.	Non-metallic pipes	S	Damage, cracks	Provide end cap
5.	Stainless steel pipes	S	Damage ,	Provide end cap
6.	MS sections, beams	S	Damage, paint, corrosion	
7.	Cable trays	S	Damage, condition of preservations	
8.	Insulation sheets	S	Damage	
9.	Insulation	C	Damage, packing	
10.	Hangers Rods	S	Damage, paint, packing	
11.	Tubes	S	Damage, paint , packing	Provide end cap
12.	Hume pipes	O	Damage	
13.	Castings	O	Damage, paint, corrosion	
Fabricated mechanical items (pressure vessels, tanks etc.)				
14.	Pressure vessels (unlined)	O	Damage, paint, corrosion,	Covered nozzles
15.	Atmospheric storage tanks (unlined)	O	Damage, paint, corrosion	Covered nozzles

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
16.	Pressure vessels (lined)	S	Damage, paint, corrosion, rubber lining	
17.	Atmospheric storage tanks(lined)	S	Damage, paint, corrosion, rubber lining	
18.	Support structures	O	Damage , paint, corrosion	
19.	Flanges	C	Damage , paint, corrosion	
20.	Fabricated pipes	S	Damage , paint, corrosion	Provide end cap
21.	Vessels internals	C	Damage , paint, corrosion ,packing	
22.	Grills	S	Damage , paint, corrosion	
23.	Angles	S	Damage , paint, corrosion	
24.	Bridge mechanism/clarifier mechanism	O	Damage , paint, corrosion	
25.	Cranes, rails	S	Damage , paint, corrosion	
26.	Stair cases	O	Damage , paint, corrosion	
27.	Ladders/handrails	O	Damage , paint, corrosion	
28.	Fabricated ducts	S	Damage , paint, corrosion	
29.	Isolation Gates	O	Damage , paint, corrosion	
30.	Fabricated boxes/panels	S	Damage , paint, corrosion	
Mechanical components like valves, fittings, cables glands, spares etc.)				
31.	Valves	S	Damage , packing	

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
32.	Fittings	S	Damage , packing	Provide end cap
33.	Cable glands	C	Damage , packing	
34.	Tools & tackles	C	Damage , packing	
35.	Nut , bolts, washers,	C	Damage , packing	
36.	Gasket & Packings	C	Damage , packing	
37.	Copper tubes	C	Damage , packing, corrosion	Provide end cap
38.	SS tubing	C	Damage , packing	Provide end cap
Rotating assemblies (pumps, blowers, stirrers, fans, compressors etc.)				
39.	Pumps	S	Damage , packing, corrosion	Shaft rotation
40.	Blowers/Compressors	S	Damage , packing, corrosion	Shaft rotation
41.	Agitators/stirrers/radial launders	C	Damage , packing, corrosion	Shaft rotation
42.	Rollers for chlorine tonner mounting	C	Damage , packing, corrosion	
43.	Centrifuge	S	Damage , packing,	
44.	Gear box	C	Damage , packing, corrosion	
45.	Bearings	C	Damage , packing, corrosion	
46.	Fans	S	Damage , packing, corrosion	
47.	Dosing skids	S	Damage , packing, corrosion	
48.	Pump assemblies	S	Damage , packing, corrosion	
49.	Air washers(INTERNALS)	S	Damage , packing	
50.	Air conditioners (split)	C	Damage , packing	

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
51.	Elevators(CONTAINERIZED)	O	Damage , packing, corrosion	
52.	Chillers/VA machines	S	Damage , packing	
53.	Air handling Unit/Package unit	S	Damage , packing	
54.	Chlorinators & Evaporators	C	Damage , packing	
55.	Ejectors	C	Damage , packing	
56.	Electrolyser	C	Damage , packing	
Miscellaneous items like chain pulley blocks, hoists etc.				
57.	Chain pulley blocks	S	Damage, Packing	
58.	Electric hoists	S	Damage, Packing	
59.	Fire extinguishers	C	Damage, expiry date	
60.	Fork Lift Truck	S	Damage, Packing	
61.	Hydraulic Mobile Crane	O	Damage, Packing	
62.	Mobile Pick Up & Carry Crane	O	Damage, Packing	
63.	Motor boats	O	Damage, Packing	
64.	Safety showers	S	Damage, Packing	
65.	Diffusers/dampers	S	Damage, Packing	
Chemicals and consumables (acid, alkali, paints, oils, reagents and special chemicals)				
66.	Hydro Chloric Acid (HCl)	Store in canes/ storage tank in dyke area	Date of production/ leakage/fumes	hazardous chemical
67.	Sulphuric acid (H_2SO_4)	Store in canes/ storage tank in dyke area	Date of production/ leakage/fumes	hazardous chemical

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
68.	Sodium hydroxide (NaOH)	Store in canes/ storage tank in dyke area	Date of production/ leakage/ fumes/ breather	hazardous chemical ,breather to be checked for air ingress
69.	Sodium hypo chlorite	To be stored under shed	Date of production/ leakage/ fumes	hazardous chemical ,self-life normally 15-30 days after which strength of chemical decays
70.	Ammonia	S	Date of production/ leakage/ fumes	Store in closed storage tanks, hazardous chemical
71.	CW treatment chemicals	S	Date of production , Self-life	Store in closed canes
72.	RO/UF cleaning chemicals	S	Date of production , Self-life	Store in closed canes
73.	Lime	C	Damage to packing , seepage	Prevent moisture, rain
74.	Alum bricks	C	Damage to packing	Prevent moisture, rain
75.	Poly electrolyte	S		Store in closed storage tanks
76.	Laboratory chemicals(powder)	C	Damage, Packing self-life	
77.	Laboratory chemicals(liquid)	C	Damage, Packing self-life	
78.	Lubrication oils	C	Leakage	
79.	Paints	S	Leakage ,air tightness	
80.	Sand	O	Damage of packing	No hooks
81.	Salt (NaCl)	C	Damage of packing, water ingress	Prevent moisture, rain
82.	Anthracite	S	Damage of packing	
83.	Activated carbon	S	Damage of packing	

Sl. No.	**Description of the equipment**	**Type of Storage**	**Check for**	**Remarks**
84.	Thermal insulation	S	Damage of packing	
85.	Cement	C	Damage of packing	Prevent moisture, rain
86.	Gravels	O	Damage of packing	
87.	ION exchange resins	C	Damage , packing	Refer manufacturer guidelines
88.	RO membranes	C	Damage , packing	Refer manufacturer guidelines
89.	UF membranes	C	Damage , packing	Refer manufacturer guidelines
90.	Cleaning chemicals	C	Damage , packing	Refer manufacturer guidelines
91.	Chemicals for analysers/calibration	C	Damage , packing	Refer manufacturer guidelines
Electrical and C & I items (motors, cables etc.)				
92.	Motors	C	Damage , packing	
93.	Cable drums	O	Damage	
94.	Control Panel /control desk, UPS ,JB	S	Damage, Packing	
95.	Instruments(gauges/analysers)	C	Damage	
Special items		As per Manufacturer's item, like Hydrogen cylinders, Ozonator, Analyser, Chlorine dioxide generators etc.		

5. CONCLUSION

Concerned storage agency at site should make sure that loss in equipment performance and wear & tear are minimised through proper storage and preservation. The above are broad guidelines and cover major equipment / materials. However specific storage practices shall be followed as per manufacturer recommendation. All the necessary measures even in addition to the ones mentioned above, if found necessary, should be taken to achieve the objective.

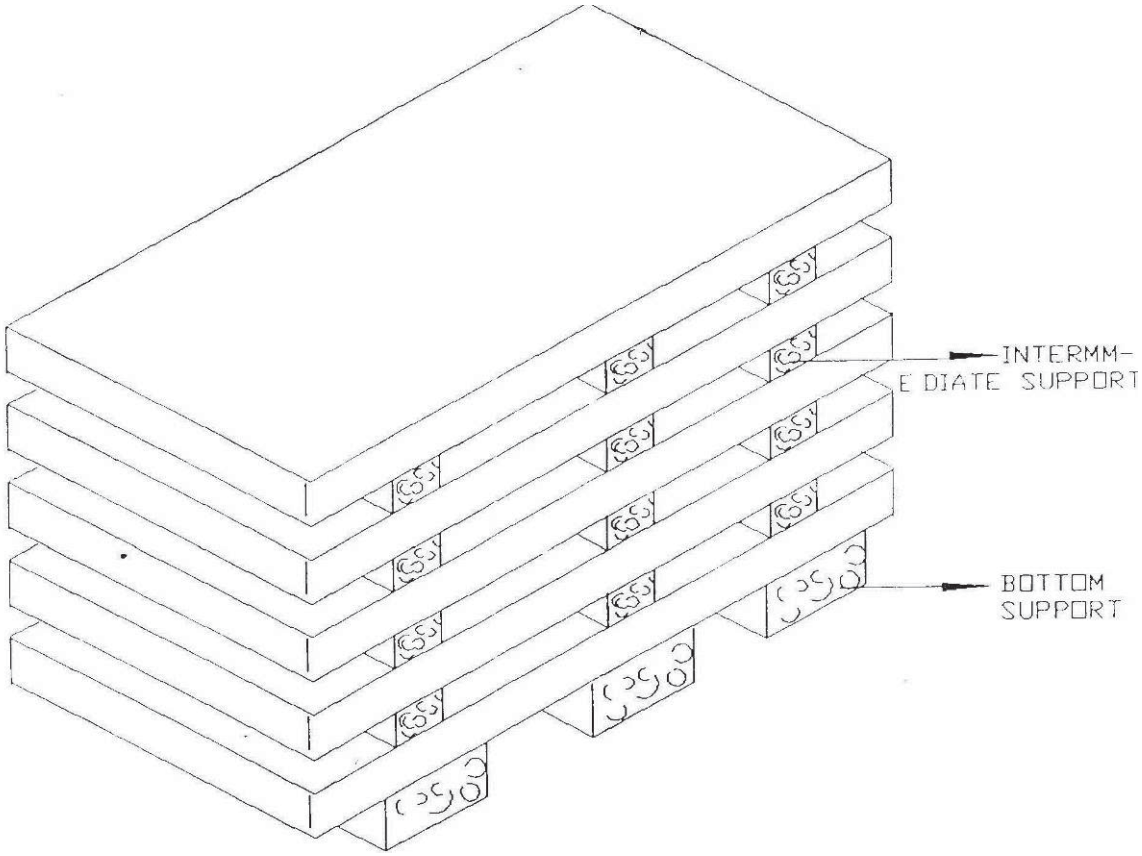

Figure – 1 – PLATE STACKING ARRANGEMENT

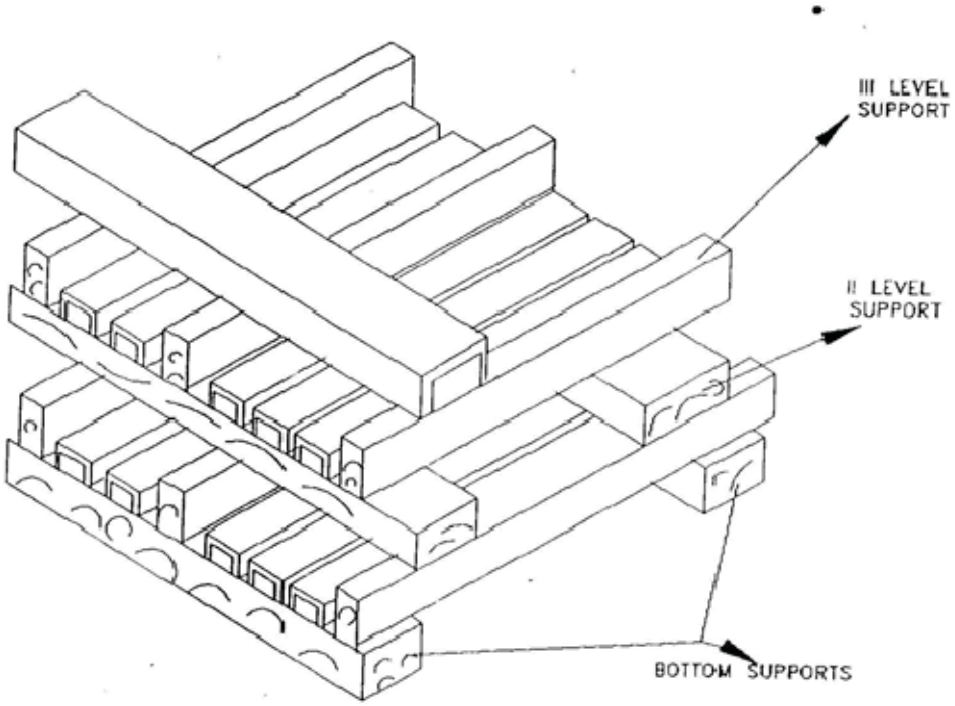

Figure – 2 – STRUCTURAL STEEL STACKING ARRANGEMENT

VOLUME-III

LIST OF DOCUMENTS TO BE SUBMITTED ALONG WITH BID

1.0 Bidder to furnish following documents/information along with the bid (For Electrical And C&I Please Refer The Respective Section Of The Specification).

- Deviation if any strictly in the enclosed Schedule of deviation with cost of withdrawal only with mention of specification clause for which deviation is being asked. (Stamped & Signed). In case of No Technical Deviation, bidder to furnish the same format stating “No Deviation” duly Stamped & Signed.
- Guaranteed Auxiliary Power Consumption Figures(Stamped & Signed)
- Compliance certificate.(Stamped & Signed)
- Schedule of Declaration. (Stamped & Signed)
- Un Price Schedule duly filled in. (Stamped & Signed)
- List of Start-up & commissioning spares if any. (Stamped & Signed)

Any other documents submitted by bidder except as asked in the bid’s specification shall not be evaluated & considered as null & void.

NOTES:

1) Any item/work either supply of equipment or erection material which have not been specifically mentioned but are necessary to complete the works for trouble free and efficient operation of the plant shall be deemed to be included within the scope of this specification. The bidder without any extra charge shall provide the same.

2) All drawings/documents shall be approved by BHEL/Customer during detailed engineering stage. Successful Bidder shall comply with the comment of the customer/BHEL without any price & delivery implication.

COMPLIANCE CUM CONFIRMATION CERTIFICATE

The bidder shall confirm compliance with following by signing/ stamping this compliance certificate and furnishing same with the offer:

1. The scope of supply, technical details, construction features, design parameters etc. shall be as per technical specification & there are no exclusions/ deviations with regard to same.
2. QP/ test procedures shall be submitted in the event of order based on the guidelines given in the specification & QP enclosed therein.
3. QP will be subject to BHEL/Customer approval in the event of order & customer hold points for inspection/ testing shall be marked in the QP at the contract stage. Inspection/ testing shall be witnessed as per same apart from review of various test certificates/ Inspection records etc. The charges for 3rd party inspection (Lloyds, TUV or equivalent) for imported components shall be included in the base price of the equipment by the bidder.
4. All drawings/data – sheets etc. to be submitted during contract shall be subject to BHEL/Customer review/ approval. GA drawings, as submitted with offer at tender stage are for reference purpose only and shall be subject to approval during contract stage.
5. There are no other deviations with respect to specification other than those furnished in the 'Schedule of Deviations'.
6. The offered materials shall be either equivalent or superior to those specified. Also for components where material is not specified it shall be suitable for intended duty, materials shall be subject to approval in the event of order.
7. The commissioning spares (if any) are supplied on 'As Required Basis' & prices for same included in the base price (If bidders reply to this is "No commissioning spares are required" and if some spares are actually required during commissioning same shall be supplied by bidder without any cost to BHEL and Customer).
8. All sub vendors shall be subject to BHEL/CUSTOMER approval.
9. Any special tools & tackles, if required, shall be in bidder's scope.
10. Performance guarantee test parameters shall stand valid till the satisfactory completion of Performance guarantee test and its acceptance by BHEL and Customer.

PRE BID CLARIFICATION SCHEDULE

All clarification from the Technical Specification shall be filled in by the BIDDER clause by clause in this format only.

VOLUME	SECTION	CLAUSE NO.	PAGE NO.	SPECIFICATION REQUIREMENT	CLARIFICATION	REASONS FOR CLARIFICATION

PARTICULARS OF BIDDER / AUTHORISED REPRESENTATIVE				
NAME	DESIGNATION	SIGNATURE	DATE	COMPANY SEAL

SCHEDULE OF DECLARATION

I ……..……certify that all the technical data and information pertaining to this specification are correct and are true representation of the equipment/system covered by our format proposal number Dated ……. and there is no deviation to the specification.

I hereby certify that I am duly authorized representative of the Bidder's company whose name appears above my signature.

Bidders Company Name …….

Authorized Representative's
Signature ……..

Name …….

Bidder's Name …….

The bidder hereby agrees to fully comply with the requirements and intent of this specification for the price indicated.

SCHEDULE OF DEVIATIONS WITH COST OF WITHDRAWAL

PROJECT:- 3X800 MW PATRATU STPP EXT.PH-I

PRE TREATMENT PLANT (PT PLANT)

TENDER ENQUIRY REFERENCE:-

NAME OF VENDOR:-

SL NO	VOULME/ SECTION	PAGE NO.	CLAUSE NO.	TECHNICAL SPECIFICATION/ TENDER DOCUMENT	COMPLETE DESCRIPTION OF DEVIATION	COST OF withdrawal OF DEVIATION	REFERENCE OF PRICE SCHEDULE ON WHICH COST OF withdrawal OF DEVIATION IS APPLICABLE	NATURE OF COST OF withdrawal OF DEVIATION (POSITIVE/ NEGATIVE)	REASON FOR QUOTING DEVIATION
TECHNICAL DEVIATIONS									
COMMERCIAL DEVIATIONS									

PARTICULARS OF BIDDERS/ AUTHORISED REPRESENTATIVE

NAME	**DESIGNATIONS**	**SIGN & DATE**	

NOTES:

1. For self manufactured items of bidder, cost of withdrawal of deviation will be applicable on the basic price (i.e. excluding taxes, duties & freight) only.
2. For directly dispatchable items, cost of withdrawal of deviation will be applicable on the basic price including taxes, duties & freight.
3. All the bidders have to list out all their Technical & Commercial Deviations (if any) in detail in the above format.
4. Any deviation not mentioned above and shown separately or found hidden in offer, will not be taken cognizance of.
5. Bidder shall submit duly filled unpriced copy of above format indicating "quoted" in "cost of withdrawal of deviation" column of the schedule above along with their Techno-commercial offer, wherever applicable.
6. Bidder shall furnish price copy of above format along with price bid.
7. The final decision of acceptance/ rejection of the deviations quoted by the bidder shall be at discretion of the Purchaser.
8. Bidders to note that any deviation (technical/commercial) not listed in above and asked after Part-I opening shall not be considered.
9. For deviations w.r.t. Payment terms, Liquidated damages, Firm prices and submission of E1/ E2 forms before claiming 10% payment, if a bidder chooses not to give any cost of withdrawal of deviation loading as per Annexure-VIII of GCC, Rev-06 will apply. For any other deviation mentioned in un-priced copy of this format submitted with Part-I bid but not mentioned in priced copy of this format submitted with Priced bid, the cost of withdrawal of deviation shall be taken as NIL.
10. Any deviation mentioned in priced copy of this format, but not mentioned in the un-priced copy, shall not be accepted.
11. All techno-commercial terms and conditions of NIT shall be deemed to have been accepted by the bidder, other than those listed in unpriced copy of this format.
12. Cost of withdrawal is to be given seperately for each deviation. In no event bidder should club cost of withdrawal of more than one deviation else cost of withdrawal of such deviations which have been clubbed together shall be considered as NIL.
13. In case nature of cost of withdrawal (positive/negative) is not specified it shall be assumed as positive.
14. In case of descrepancy in the nature of impact (positive/ negative), positive will be considered for evaluation and negative for ordering.

FORMAT FOR GUARANTEED AUXILIARY POWER CONSUMPTION FIGURES (TO BE FILLED BY THE BIDDER)

S.NO.	DESCRIPTION OF EQUIPMENT	NO OF EQUIPMENT		TOTAL GUARANTEED POWER CONSUMPTION FOR WORKING DRIVES AT MOTOR INPUT TERMINAL (IN KW)
		WORKING	STANDBY	
1.	Potable water pumps (Plant)	1	1	
2.	Potable water pumps (Colony)	1	1	
		TOTAL (KW)		

Note-Estimated auxiliary power consumption (EPC) figure for the potable water pumps (for working drives only) has been indicated in **Annexure-IIIA**. So long bidder's quoted guaranteed auxiliary power consumption (GPC) above remains within this EPC, there will be no technical loading of bid on power consumption for evaluation. However, if bidder's quoted GPC exceeds EPC, there shall be technical loading of bid for evaluation @ US$ 2179 (US Dollar Two Thousand One Hundred Seventy Nine only) per KW of additional power over EPC.

Bidder’s guaranteed power consumption as furnished in relevant schedule shall be demonstrated by the successful bidder during performance testing at works/ site. In case power consumption is noted higher than EPC/ bidder's quoted GPC whichever is higher, during inspection/ PG test, penalty @ US$ 3025 (US Dollar Three Thousand Twnty Five only) per additional KW shall be levied on vendor.(+) 1.0% of the guaranteed Auxiliary Power Consumption shall be acceptable shortfall with LD.

DOLLAR RATE SHALL BE APPLICABLE AS PER ORDER RECIEVED DATE FROM NTPC (I.E. 08.03.2018).