1X600 MW PANKI TPS
UTTAR PRADESH RAJYA VIDYUT UTPADAN NIGAM LIMITED

VOLUME – II B & III

TECHNICAL SPECIFICATION
FOR
SEWAGE TREATMENT PLANT

SPECIFICATION NO.: PE-TS-426-673A-A001 REV 00

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 **SEWAGE TREATMENT PLANT** as per the details in different sections / volumes of this specification for **1X600 MW PANKI TPS EXT.**

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 Sewage Treatment Plant.

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 (UPRVUNL: Utter Pradesh Rajya Vidyut Utpadan Nigam 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 equipment is being manufactured or tested and all test records shall be made available to him.

SECTION – B

PROJECT INFORMATION

CHAPTER 2 : GENERAL PROJECT INFORMATION

1.0 PROJECT INFORMATION

1.1	Owner	:	**UTTAR PRADESH RAJYA VIDYUT UTPADAN NIGAM LIMITED, LUCKNOW**	
1.2	Project Title	:	Panki Thermal Power Station (1x660MW)	
1.3	Owner's Engineer	:	**DEVELOPMENT CONSULTANTS PVT. LTD**	
1.4	Project Site Location	:	Place	Panki
			District	Kanpur
			State	Uttar Pradesh
			Country	India
1.5	Latitude & Longitude of project site	:	North	$N26^0 28'20"$
			East	$E\ 80^0 14'32"$
1.6	Nearest Railway Station	:	Panki	5 km
1.7	Nearest Town	:	Kanpur	16km
1.8	Nearest Highway	:	National Highway - 25	
1.9	Nearest Airport	:	Kanpur	25 km
			Lucknow	80 Km
1.10	Nearest Commercial Airport	:	Delhi	140 km
1.11	Nearest Water Body	:	Lower Ganga Canal, adjacent to site	
1.12	Land	:	Land is in possession of UPRVUNL.	
1.13	Station Graded Level Elevation from Mean sea level (MSL)	:	Plant FGL → RL(+) 126.0M → El(-) 0.500M Plant FFL → RL(+) 126.5M → El(+/-) 0.000M	
1.14	Water			
1.14.1	Nearest Water Source	:	Lower Ganga Canal system running adjacent for project site	
1.14.2	Water Requirement for station	:	~ 1927 m^3/hr considering closed cooling cycle with NDCT. Additional 700m^3/hr for ash slurry preparation during emergency ash disposal to ash dyke.	
1.14.3	Raw Water Analysis from Upper Ganga Canal	:	Refer Appendix - I	
1.15	Site Ambient Condition			
1.15.1	Monthly mean (DBT)	:	Maximum	44.4 °C
		:	Minimum	3.8 °C
1.15.2	Extreme Recorded (DBT)	:	Maximum	47.3 °C
			Minimum	-0.9 °C
1.15.3	Monthly mean (WBT)	:	Maximum Minimum	27.3 °C 9.2 °C
1.15.4	Relative Humidity	:	Maximum	84 %
			Minimum	28 %
1.15.5	Average relative humidity		Annual Average	65 %
1.15.6	Rainfall	:	Annual average	832.6 mm

			Heaviest fall recorded in 24 hrs	247.4 mm
1.15.7	Basic Wind Speed	:	47.00 m/s	As per IS: 875 part – III
			For wind resistance design of structure & equipment refer relevant civil section	
1.15.8	Climatic condition	:	For detailed information refer attached Climatological data as published by IMD for Kanpur station.	
1.16	Seismic data	:	Zone – III	As per IS: 1893
			For earthquake resistance design of structure & equipment refer relevant civil section	
1.17	Fuel Data			
1.17.1	Coal Source	:	Coal requirement for this stage of the project is estimated as 2.99 million tones/annum considering 660 MW capacity, GCV of blended coal 4030 kcal/kg, Heat Rate as 2317 kcal/kwh and 90% PLF as per CERC operative norms effective from 1/4/2009.	
1.17.2	Coal Transportation	:	Thru BOXN wagons of Indian Railways System	
1.17.3	Coal Analysis	:	Refer Appendix – II	
1.17.4	Support Fuel (HFO / LDO) transportation	:	Support fuel will be transported by road tankers or by Railway system. Start-up / support fuel for the proposed project will be LDO/HFO.	
1.17.5	Support Fuel (HFO / LDO) analysis	:	Refer Appendix - II	

Appendix – I: Raw Water Analysis (Source - Lower Ganga Canal)

S. No.	Description	Unit	Parameter
1	Physical characteristics		
	pH at 25^0C	-	8.00
	Turbidity	Silica Scale	500
	Total Suspended solids	ppm	250
	Total Dissolved solids	ppm	241
	Colour	Hazen	< 5
2	Cations		
	Calcium Hardness	ppm as $CaCO_3$	80
	Magnesium Hardness	ppm as $CaCO_3$	40
	Sodium + Potassium	ppm as $CaCO_3$	36
	Iron	ppm as $CaCO_3$	1.5
	Total Cations	ppm as $CaCO_3$	157.5
3	Anions		
	Bicarbonate	ppm as $CaCO_3$	100
	Carbonate	ppm as $CaCO_3$	0.95

S. No.	Description	Unit	Parameter
	Hydroxyl	ppm as $CaCO_3$	0.05
	Chlorides	ppm as $CaCO_3$	20
	Sulphate	ppm as $CaCO_3$	36
	Nitrate	ppm as $CaCO_3$	0.5
	Total Anions	ppm as $CaCO_3$	157.5
4	Carbon Di-oxide as CO_2	ppm	1.97
5	Dissolved Silica	ppm as SiO_2	10.0
6	Colloidal Silica	ppm as SiO_2	0.5
7	Organic Matter	ppm as O2	4.0

Appendix – II : Coal Quality Parameter

Sl.No.	Particulars	Unit	Performance / Design Fuel	Worst Fuel	Best Fuel
1.0.	**Proximate Analysis (As Received Basis)**	**By Weight**			
1.1.	Moisture	%	10.5	12	12
1.2.	Ash	%	35	43	32
1.3.	Volatile Matter	%	26	19	27
1.4.	Fixed Carbon	%	28.5	26	29
1.5.	**Total**	%	**100**	**100**	**100**
1.6.	**Gross Calorific Value**	**kcal/kg**	**3700**	**3200**	**4200**
2.0.	**Ultimate Analysis (As Received Basis)**				
2.1.	Moisture	%	10.5	12	12
2.2.	Ash	%	35	43	32
2.3.	Carbon	%	42	33.5	44
2.4.	Hydrogen	%	2.0	2.4	2.77
2.5.	Nitrogen	%	1.6	1.3	1.5
2.6.	Sulfur	%	0.46	0.45	0.5
2.7.	Oxygen	%	8.44	7.35	7.23
2.8.	**Total**	%	**100**	**100**	**100**
3.0.	**Hard Groove Index**		**53**	**50**	**55**
4.0.	**Ash Fusion Range**				
a)	Initial Deformation Temperature	^0C	1200	1154	1165
b)	Hemispherical Temperature	^0C	1350	1300	>1350

Sl.No.	Particulars	Unit	Performance / Design Fuel	Worst Fuel	Best Fuel
c)	Fusion Temperature	^{0}C	>1400	>1400	>1400

Source: Saharpur Jamarpani Coal Mine, Jharkhand

Imported Coal

Sl. No.	Item	Unit	Design Coal
1.	Gross heating Value	Kcal/kg	5500

Source*: Indonesia / South African coal*

Appendix – III : Light Diesel Oil (LDO)
As per IS: 1460-2000

S.No.	Property	Unit	Value
1.0	Ash content (max)	% by mass	0.02
2.0	Carbon residue (Rams Bottom) max	% by mass	0.2
3.0	Cetane number (Min)	-	-
4.0	Pour Point (max) a) Winter b) Summer	°C	 12 21
5.0	Flash Point (min) a) Abel b) Pensky0Martens	°C	 -- 68
6.0	Kinematic Viscosity at 38 deg	Cst	2.5 to 15.7
7.0	Sediments (max)	% by mass	0.1
8.0	Sulphur Content (max)	% by mass	1.8
9.0	Water Content (max)	% by volume	---
10.0	Gross Calorific Value (GCV), approx	kCal/kg	10,000
11.0	Density at 15°C	Kg/m^3	850 to 870

Appendix – IV : Heavy Fuel Oil (HFO)
As per IS: 1593-1982

S.No.	Property	Unit	Value
1.0	Viscosity at 50 °C	Cst	370
2.0	Density at 15°C (approx)	Kg/m^3	890 to 950
3.0	Flash Point (min)	°C	66
4.0	Pour Point (max)	°C	20
5.0	Water Content (max)	% by volume	1
6.0	Sediments (max)	% by weight	0.25
7.0	Sulphur Content (max)	% by weight	4.5
8.0	Ash content (max)	% by weight	0.1
9.0	Gross Calorific Value (GCV), approx	kCal/kg	10,000

2.0 Access to Site

The nearest town Kanpur is about 16 km from site. It is easily accessible by Railway/Road.

Dedicated railway link is available for the transportation of coal and fuel oil for the power plant. No problem is envisaged in accessibility and transportation of heavy equipment to site by road or rail.

3.0 Plant Rating, Capacity, Availability, PLF

Plant continuous rating will be 660 MW at generator terminals based on the following site conditions.

- Ambient air temperature
- Condenser cooling water inlet temperature of 33°C and 10°C temperature rise across the condenser.
- Generator power factor of 0.85 (zero point eight-five).
- Fuel specification as given elsewhere.
- Design temperature for electrical equipment is 50°C.

The VWO capacity of the steam turbine 660 MW will be 105% or 693 MW and the Boiler maximum Continuous Rating (MCR) will be established to match the steam requirement at VWO conditions. The capacity of the unit is selected so as to deliver the rated output even after ageing that will occur between overhauls, as a result of deposition of salts in turbine blades, wear and tear etc.

4.0 Power Evacuation

The power generated from the proposed project will be evacuated over the 400 KV through a 400 KV open switchyard. Further to Switchyard distribution will be by UPTRANSCO. Interconnection of proposed 400 KV Switchyard with existing 220 kV switchyard shall be done as specified elsewhere in specification.

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जलवायवी सारणी
CLIMATOLOGICAL TABLE

स्टेशन :कानपुर (ए)
STATION :Kanpur (A)

अक्षांश LAT 26°26′ N देशांतर LONG 80°22′ E समुद्री तल माध्य से ऊँचाई HEIGHT ABOVE M. S. L. मीटर 126 METRES

1951 से 1976 तक के प्रेक्षणों पर आधारित
BASED ON OBSERVATIONS FROM 1951 TO 1976

वायु तापमान — AIR TEMPERATURE

माध्य — MEAN

माह MONTH	स्टेशन का सतह दाब STATION LEVEL PRESSURE एच. पी. ए. hPa	शुष्क बल्ब DRY BULB डि.से. °C	नम बल्ब WET BULB डि.से. °C	दैनिक अधिकतम DAILY MAX डि.से. °C	दैनिक न्यूनतम DAILY MIN डि.से. °C	माह में उच्चतम HIGHEST IN THE MONTH डि.से. °C	माह में निम्नतम LOWEST IN THE MONTH डि.से. °C
जनवरी JAN	I 1002.8 II 1000.2	11.3 20.1	9.5 14.2	22.7	8.5	27.1	4.4
फरवरी FEB	I 1000.2 II 997.4	15.0 24.6	11.7 16.0	26.4	11.3	31.9	6.7
मार्च MAR	I 997.4 II 993.9	21.5 30.9	15.6 19.0	32.5	16.6	38.2	11.1
अप्रैल APR	I 993.6 II 989.8	28.5 36.6	18.8 21.4	38.3	22.0	42.5	16.7
मई MAY	I 988.9 II 985.2	32.4 39.7	21.8 23.3	41.4	26.5	45.0	21.7
जून JUN	I 985.1 II 981.5	32.4 37.7	24.8 25.7	40.1	28.7	44.8	23.8
जुलाई JUL	I 984.8 II 982.1	29.0 31.9	26.2 26.8	34.3	26.7	39.8	23.8
अगस्त AUG	I 986.5 II 984.3	27.9 30.0	26.1 26.8	32.2	25.9	35.6	23.7
सितम्बर SEP	I 990.5 II 987.3	27.8 30.5	25.2 25.7	33.0	24.9	35.8	22.2
अक्तूबर OCT	I 996.7 II 993.6	25.0 29.5	21.0 22.5	32.7	20.2	35.6	15.4
नवम्बर NOV	I 1001.4 II 998.4	18.3 25.1	14.5 17.8	29.0	13.2	32.7	8.8
दिसम्बर DEC	I 1003.1 II 1000.4	12.6 20.8	10.3 14.8	24.2	8.9	28.1	4.8
वार्षिक योग या माध्य ANNUAL TOTAL OR MEAN	I 994.3 II 991.2	23.5 29.6	18.8 21.2	32.2	19.5	45.6	3.7
वर्षों की संख्या NUMBER OF YEARS	I 23 II 23	23 23	23 23	24	24	24	24

चरम — EXTREMES

माह MONTH	उच्चतम HIGHEST डि.से. °C	दिनांक और वर्ष DATE AND YEAR	निम्नतम LOWEST डि.से. °C	दिनांक और वर्ष DATE AND YEAR
जनवरी JAN	31.1	21 1939	1.7	14 @ 1967
फरवरी FEB	35.6	28 1930	0.6	02 1905
मार्च MAR	42.8	27 1941	7.2	07 1945
अप्रैल APR	45.6	30 1938	11.1	03 1905
मई MAY	47.2	30 1941	17.8	03 1909
जून JUN	47.3	09 1966	20.6	03 1922
जुलाई JUL	45.0	10 1903	21.7	28 1948
अगस्त AUG	40.6	01 1903	21.7	25 1948
सितम्बर SEP	40.0	02 1932	16.1	27 1896
अक्तूबर OCT	40.6	03 1896	11.1	30 1895
नवम्बर NOV	36.1	04 1940	5.0	19 1948
दिसम्बर DEC	31.3	15 1959	-0.9	27 1961
वार्षिक योग या माध्य ANNUAL TOTAL OR MEAN	47.3		-0.9	
वर्षों की संख्या NUMBER OF YEARS	90		90	

आर्द्रता — HUMIDITY

माह MONTH	सापेक्ष आर्द्रता RELATIVE HUMIDITY प्रतिशत %	वाष्प दाब VAPOUR PRESSURE एच.पी.ए. hPa
जनवरी JAN	I 79 II 50	10.5 11.5
फरवरी FEB	I 66 II 38	11.1 11.3
मार्च MAR	I 52 II 29	13.0 12.3
अप्रैल APR	I 37 II 23	14.1 12.9
मई MAY	I 37 II 22	17.3 14.9
जून JUN	I 54 II 39	24.9 22.9
जुलाई JUL	I 80 II 68	31.8 31.2
अगस्त AUG	I 87 II 77	32.5 32.5
सितम्बर SEP	I 81 II 68	29.9 29.5
अक्तूबर OCT	I 69 II 54	21.5 21.2
नवम्बर NOV	I 65 II 46	13.6 14.6
दिसम्बर DEC	I 76 II 50	10.8 11.8
वार्षिक योग या माध्य ANNUAL TOTAL OR MEAN	I 65 II 47	19.3 18.9
वर्षों की संख्या NUMBER OF YEARS	I 23 II 23	23 23

मेघ की मात्रा — CLOUD AMOUNT

माह MONTH	समस्त मेघ ALL CLOUDS आकाश के अष्टमांश Oktas of sky	निम्न मेघ LOW CLOUDS आकाश के अष्टमांश Oktas of sky
जनवरी JAN	I 1.8 II 1.8	0.6 0.5
फरवरी FEB	I 1.4 II 1.6	0.4 0.3
मार्च MAR	I 1.6 II 1.8	0.3 0.4
अप्रैल APR	I 1.3 II 1.7	0.3 0.4
मई MAY	I 1.1 II 1.2	0.4 0.4
जून JUN	I 3.5 II 3.5	1.2 1.3
जुलाई JUL	I 5.9 II 6.1	3.2 3.1
अगस्त AUG	I 6.2 II 5.9	4.0 3.6
सितम्बर SEP	I 4.0 II 4.1	2.3 2.2
अक्तूबर OCT	I 1.4 II 1.6	0.8 0.8
नवम्बर NOV	I 0.8 II 0.9	0.3 0.2
दिसम्बर DEC	I 1.3 II 1.4	0.3 0.2
वार्षिक योग या माध्य ANNUAL TOTAL OR MEAN	I 2.5 II 2.6	1.2 1.1
वर्षों की संख्या NUMBER OF YEARS	I 23 II 23	13 13

वर्षा — RAINFALL

माह MONTH	मासिक योग MONTHLY TOTAL मि.मि. mm	वर्षा के दिनों की संख्या NO. OF RAINY DAYS	वर्षसहित सबसे नम महीने का योग TOTAL IN WETTEST MONTH WITH YEAR मि.मि. mm	वर्षसहित शुष्कतम महीने का योग TOTAL IN DRIEST MONTH WITH YEAR मि.मि. mm	24 घंटों की सबसे भारी वर्षा HEAVIEST FALL IN 24 HOURS मि.मि. mm	दिनांक और वर्ष DATE AND YEAR	माध्य पवन गति MEAN WIND SPEED कि.मी. प्र. घं. Kmph
जनवरी JAN	21.1	1.5	74.7 1948	0.0	48.5	04 1893	8.0
फरवरी FEB	12.5	1.0	97.5 1928	0.0	59.2	20 1942	9.9
मार्च MAR	6.2	0.7	77.2 1944	0.0	61.7	30 1944	11.3
अप्रैल APR	4.5	0.5	94.2 1909	0.0	25.9	09 1928	12.2
मई MAY	9.8	0.8	47.2 1969	0.0	40.0	12 1969	12.7
जून JUN	65.4	3.3	378.7 1916	6.0 1969	133.3	10 1916	13.4
जुलाई JUL	229.8	12.0	704.1 1924	36.6 1970	181.0	25 1965	11.2
अगस्त AUG	289.5	13.3	664.2 1921	40.0 1965	235.2	31 1915	9.6
सितम्बर SEP	124.4	6.5	527.6 1915	5.2 1966	242.8	16 1970	9.2
अक्तूबर OCT	60.7	2.1	335.3 1955	0.0	136.1	05 1894	6.4
नवम्बर NOV	1.0	0.2	92.2 1894	0.0	59.2	19 1911	5.3
दिसम्बर DEC	7.7	0.7	82.6 1967	0.0	40.6	25 1950	6.0
वार्षिक योग या माध्य ANNUAL TOTAL OR MEAN	832.6	42.6	1567.2 1955	420.6 1918	242.8		9.6
वर्षों की संख्या NUMBER OF YEARS	25	25	85	85	85		22

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जलवायवी सारणी
CLIMATOLOGICAL TABLE

स्टेशन :कानपुर (ए)
STATION : Kanpur (A)

माह	मौसम परिघटना के साथ दिनों की संख्या: वर्षण 0.3 मि.मि. या अधिक	ओले	गर्जन	कुहरा	धूल भरी आंधी	चंड वात	पवन की गति के साथ दिनों की संख्या (कि. मी. प्र. घं.): 62 या अधिक	20–61	1–19	0	पवन की दिशा के दिनों की संख्या का प्रतिशत: उ	उपू	पू	दपू	द	दप	प	उप	शांत	मेघ मात्रा (सभी मेघ) सहित दिनों की संख्या – अष्टमांश: 0	ले-2	3-5	6-7	8	निम्न स्तरी मेघ मात्रा सहित दिनों की संख्या – अष्टमांश: 0	ले-2	3-5	6-7	8	कुहरा 8	दृश्यता सहित दिनों की संख्या: 1 कि.मी. तक	1–4 कि.मी.	4–10 कि.मी.	10–20 कि.मी.	20 कि.मी. से अधिक
MONTH	WEATHER PHENOMENA: No. OF DAYS WITH: PPT 0.3mm or more	HAIL	THUNDER	FOG	DUST STORM	SQUALL	WIND: No. OF DAYS WITH WIND SPEED (Km. p. h.): 62 or more	20-61	1-19	0	PERCENTAGE No. OF DAYS WIND FROM: N	NE	E	SE	S	SW	W	NW	CALM	CLOUD: No. OF DAYS WITH CLOUD AMOUNT (ALL CLOUDS) OKTAS: 0	T-2	3-5	6-7	8	No. OF DAYS WITH LOW CLOUD AMOUNT OKTAS: 0	T-2	3-5	6-7	8	FOG 8	VISIBILITY: No. OF DAYS WITH VISIBILITY: UP TO 1 Km	1-4 Kms	4-10 Kms	10-20 Kms	OVER 20 Kms
जनवरी I	2.4	0.1	0.4	3.2	0.1	0.0	0	0	22	9	6	5	13	3	2	9	29	8	25	18	4	3	3	3	25	2	2	0	1	1	1.5	11.1	14.4	3.8	0.2
JAN II							0	0	24	7	11	7	11	2	1	2	39	13	14	18	5	3	3	2	26	2	2	0	1	0	0.0	1.9	20.9	7.4	0.8
फरवरी I	2.0	0.0	0.7	1.0	0.1	0.0	0	0	22	6	6	5	12	3	2	11	36	7	18	19	3	3	2	1	24	1	2	1	0	0	0.9	6.3	16.0	4.8	0.0
FEB II							0	1	24	3	9	6	8	1	1	4	46	17	8	17	3	4	3	1	25	2	1	0	0	0	0.0	0.8	19.7	7.5	0.0
मार्च I	1.4	0.0	1.1	0.1	0.4	0.3	0	0	27	4	6	5	10	4	4	14	36	10	11	19	4	4	3	1	28	1	1	1	0	0	0.0	6.2	19.6	5.2	0.0
MAR II							0	2	28	1	9	4	6	1	1	2	50	23	4	18	4	4	4	1	27	2	2	0	0	0	0.0	1.9	21.1	8.0	0.0
अप्रैल I	1.0	0.0	0.9	0.0	0.6	0.0	0	1	26	3	5	5	13	6	6	10	35	13	7	19	4	4	2	1	26	2	2	0	0	0	0.1	4.1	18.8	7.0	0.0
APR II							0	2	26	2	10	5	7	1	1	4	42	28	2	18	4	4	3	1	26	2	2	0	0	0	0.1	3.5	19.6	6.8	0.0
मई I	1.4	0.0	1.8	0.1	1.9	0.0	0	1	28	2	7	6	20	7	5	7	31	12	5	21	3	5	1	1	27	2	2	0	0	0	0.1	6.1	17.6	7.2	0.0
MAY II							0	2	28	1	11	8	10	2	1	3	37	28	0	21	4	4	2	0	26	3	2	0	0	0	0.5	4.1	18.9	7.5	0.0
जून I	5.2	0.0	2.8	0.0	1.6	0.0	0	2	26	2	5	8	27	9	4	7	28	9	3	11	3	5	7	4	17	4	6	2	1	0	0.1	5.1	19.1	5.7	0.0
JUN II							0	3	25	2	12	10	19	4	3	4	25	20	3	11	3	7	6	3	16	6	6	1	1	0	0.1	6.4	17.2	6.3	0.0
जुलाई I	15.1	0.0	2.1	0.0	0.0	0.0	0	1	29	1	4	6	33	9	9	14	18	3	4	1	2	7	10	11	8	4	11	5	3	0	0.1	2.4	21.8	6.7	0.0
JUL II							0	1	28	2	9	10	30	7	6	8	17	9	4	1	1	8	12	9	5	7	13	4	2	0	0.1	1.9	22.1	6.9	0.0
अगस्त I	17.1	0.0	1.8	0.0	0.0	0.0	0	0	28	3	4	7	32	12	6	11	20	2	6	0	2	6	10	13	4	5	12	6	4	0	0.3	2.7	19.3	8.7	0.0
AUG II							0	0	27	4	8	7	26	9	5	11	22	4	8	1	1	7	13	9	3	7	14	4	3	0	0.1	2.1	19.3	9.5	0.0
सितम्बर I	9.3	0.0	2.2	0.1	0.0	0.0	0	1	27	2	5	8	26	7	5	8	27	5	9	6	4	7	8	5	11	6	7	4	2	0	0.1	2.2	18.1	9.6	0.0
SEP II							0	0	27	3	15	10	21	4	5	4	23	7	11	5	4	9	8	4	9	9	9	2	1	0	0.1	1.3	18.9	9.7	0.0
अक्तूबर I	2.8	0.0	1.1	0.2	0.1	0.0	0	0	24	7	6	6	16	4	4	10	28	5	21	20	4	2	2	3	25	2	2	1	1	0	0.1	3.7	19.4	7.8	0.0
OCT II							0	0	22	9	18	7	11	1	1	2	20	10	30	18	5	4	2	2	22	4	3	1	1	0	0.1	0.9	19.8	10.2	0.0
नवम्बर I	0.3	0.0	0.1	0.1	0.1	0.0	0	0	19	11	6	4	7	2	2	7	27	7	38	23	3	2	1	1	28	1	1	0	0	0	0.3	9.8	14.6	5.3	0.0
NOV II							0	0	17	13	15	4	3	0	0	2	20	10	46	22	4	2	1	1	28	1	1	0	0	0	0.0	1.6	19.9	8.5	0.0
दिसम्बर I	1.0	0.0	0.1	2.4	0.0	0.0	0	0	18	13	6	5	8	1	1	6	29	7	37	23	3	2	2	1	28	1	1	0	0	1	2.3	11.2	13.9	3.6	0.0
DEC II							0	0	21	10	13	4	6	1	0	2	33	9	32	21	4	3	2	1	29	1	1	0	0	0	0.1	2.9	22.6	5.4	0.0
वार्षिक I	59.0	0.1	15.1	7.2	4.9	0.3	0	6	296	63	6	6	18	6	4	10	29	7	14	180	39	50	51	45	251	31	49	20	12	2	5.9	70.9	212.6	75.4	0.2
योग या भव्य ANNUAL TOTAL II OR MEAN							0	11	297	57	12	7	13	3	2	4	31	15	13	171	42	59	59	34	242	46	56	12	9	0	1.2	29.3	240.0	93.7	0.8
वर्षों की सं. I				20				17						22								18						18					
NUMBER OF YEARS II								17						22								18						18					

SECTION-C1
(SEWAGE TRATMENT PLANT)

- **SPECIFIC TECHNICAL REQUIREMENT (MECHANICAL)**
- **DATASHEET-A**
- **P & ID FOR SEWAGE TRAETMENT PLANT.**

1.0 GENERAL

This specification is intended to cover design (i.e. Preparation and submission of drawing/ documents including " As Built " drawings and O&M Manuals), engineering, manufacture, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting, maintenance tools & tackles (as applicable), fill of lubricants & consumables (excluding chemicals), mandatory spares along with spares for erection, start up and commissioning as required, forwarding, proper packing, shipment and delivery at site, unloading, handling, transportation & storage at site, in site transportation, assembly, minor civil works, erection & commissioning, trial run at site, preparation of drawings in 3D and carrying out performance guarantee /Functional / Demonstration tests at site (As applicable), training of customer/ client O&M staff & final handing over to end customer in flawless condition for project and package specified above complete with all accessories for the total scope defined as per BHEL NIT & tender technical specification no. PE-TS-426-673A-A001 for Sewage treatment plant package of **1X600 MW PANKI TPS.**

2.0 REFERENCE DOCUMENTS

A.	PE-DG-426-673-A001	:	P & ID FOR SEWAGE TREATMENT PLANT
B.	DATASHEET – A	:	FOR ABOVE SYSTEM
C.	PE-DG-426-100-M001	:	PLOT PLAN

3.0 SCOPE OF SUPPLY (MECHANICAL)

Following are in bidder's scope of supply:

Broad scope of work of this package includes all equipment and accessories. Please also refer Mechanical data sheet, P&ID and the respective section of Electrical and C&I sections for respective scopes.

3.1.1 Two (2) nos.(1W+1S) submersible grinding type sewage transfer pumps for sewage sump (S1) complete with all instrumentation, valves, piping, motor, etc.

3.1.2 Two (2) nos.(1W+1S) submersible grinding type sewage transfer pumps for sewage sump (S2) complete with all instrumentation, valves, piping, motor, etc.

3.1.3 Two (2) nos.(1W+1S) submersible grinding type sewage transfer pumps for sewage sump (S3) complete with all instrumentation, valves, piping, motor, etc.

3.1.4 Two (2) nos.(1W+1S) submersible grinding type sewage transfer pumps for sewage sump (S4) complete with all instrumentation, valves, piping, motor, etc.

3.1.5 Two (2) nos.(1W+1S) submersible grinding type sewage transfer pumps for sewage sump (S5) complete with all instrumentation, valves, piping, motor, etc.

3.1.6 Two (2) nos.(1W+1S) submersible grinding type sewage transfer pumps for sewage sump (S6) complete with all instrumentation, valves, piping, motor, etc.

3.1.7 Two (2) nos.(1W+1S) submersible grinding type sewage transfer pumps for sewage sump (S7) complete with all instrumentation, valves, piping, motor, etc.

3.1.8 Two (2) nos.(1W+1S) submersible grinding type sewage transfer pumps for sewage sump (S8) complete with all instrumentation, valves, piping, motor, etc.

3.1.9 Two (2) nos.(1W+1S) submersible grinding type sewage transfer pumps for sewage sump (S9) complete with all instrumentation, valves, piping, motor, etc.

3.1.10 Two (2) nos.(1W+1S) submersible grinding type sewage transfer pumps for sewage sump (S10) complete with all instrumentation, valves, piping, motor, etc.

3.1.11 Two (2) nos.(1W+1S) submersible grinding type sewage transfer pumps for sewage sump (S11) complete with all instrumentation, valves, piping, motor, etc.

3.1.12 Two (2) nos.(1W+1S) submersible grinding type sewage transfer pumps for sewage sump (S12) complete with all instrumentation, valves, piping, motor, etc.

3.1.13 Two (2) nos.(1W+1S) submersible grinding type sewage transfer pumps for sewage sump (S13) complete with all instrumentation, valves, piping, motor, etc. (Location to be finalized during detailed engineering)

3.1.14 Two (2) nos.(1W+1S) submersible grinding type sewage transfer pumps for common sewage collection sump complete with all instrumentation, valves, piping, motor, etc.

3.1.15 All instrumentation and accessories in sewage sump S1, S2, S3, S4, S5, S6, S7, S8, S9, S10, S11, S12, & S13 (RCC work in BHEL scope).

3.1.16 All instrumentation and accessories in common sewage collection sump (RCC work in BHEL scope) located in STP area.

3.1.17 Two (2) nos. (1W + 1S) oil free type air blowers with electric motor drives for supplying air required for sludge holding tank & equalization tank. Each blower shall be complete with motor, v-belt drive with belt guard, inlet filter/silencer, flexible couplings and discharge snubber, all mounted on a single base. Relief valve(s) shall be provided as required. Acoustic hood for air blowers shall also be provided by the bidder.

3.1.18 One (1) no. bar screen chamber of MOC RCC (RCC work in BHEL scope) with bars/coarse screen (MOC: **SS-304 fitted with SS 304 frame)** inclined at 60° and spacing between bars shall be 10 mm for screening of incoming sewage shall be provided by bidder.

3.1.19 One (1) no. oil & grease chamber of MOC RCC (RCC work in BHEL scope) provided with oil & grease trap for removal of oil & grease from the incoming sewage shall be provided by bidder. Mechanical items Baffle arrangement and perforated pipes etc. shall be provided by bidder.

3.1.20 One (1) no. above ground equalization tank of RCC construction (RCC work in BHEL scope) of minimum retention time of 8 hours located in STP area.

3.1.21 Two (2) nos.(1W+1S) vertical submersible grinding type MBBR feed pumps for equalization tank complete with all instrumentation, valves, piping, motor, etc.

3.1.22 All instrumentation and accessories in equalization tank (RCC work in BHEL scope) located in STP area.

3.1.23 One (1) no. above ground MBBR reactor of MSRL construction (Capacity as per process requirement) located in STP area. Media for MBBR reactor shall be of MOC PVC.

3.1.24 Two (2) nos. (1W + 1S) oil free type air blowers with electric motor drives for supplying air required for MBBR reactor. Each blower shall be complete with motor, v-belt drive with belt guard, inlet filter/silencer, flexible couplings and discharge snubber, all mounted on a single base. Relief valve(s) shall be provided as required. Acoustic hood for air blowers shall also be provided by the bidder.

3.1.25 One no. above ground tube settler (secondary settler) shall be in bidder' scope. Material of construction of settler shall be MSRL and MOC of media shall be PVC.

3.1.26 One (1) no. above ground hypo contact cum filter feed tank of PVC construction located in STP area.

3.1.27 All instrumentation and accessories in hypo contact cum filter feed tank (RCC work in BHEL scope) located in STP area.

3.1.28 Two (2) nos.(1W+1S) horizontal centrifugal type filter feed pumps for hypo contact cum filter feed tank complete with all instrumentation, valves, piping etc. for feeding water to Dual media filter & activated carbon filter for tertiary treatment. This pump has to be also cater the backwash requirement of Dual media filter & activated carbon filter

3.1.29 One (1) no. Sodium hypochlorite dosing tank (MOC: MSRL) of minimum 200 ltrs. capacity for dosing chemical to hypo contact cum filter feed tank/ centrifuge feed line, complete with instrumentation, dissolving basket

and slow speed (100-200 rpm) agitator of SS-316 construction. MOC of dissolving basket will be SS-316.

3.1.30 Three (3) no. Sodium hypochlorite dosing pump (MOC: PP) complete with all instrumentation and accessories, valves, piping, motor, etc. as per P&ID of sewage treatment plant (i.e. dosing hypo to hypo contact cum filter feed tank/ centrifuge feed line).

3.1.31 One (1) no. (1X100%) dual media filter (MOC: Epoxy coated carbon steel) along with filter media, piping, valves, fittings, instrumentation and accessories associated with the same.

3.1.32 One (1) no. (1X100%) Activated Carbon Filter (MOC: Epoxy coated carbon steel) along with media, carbon trap, piping, valves, fittings, instrumentation and accessories associated with the same.

3.1.33 One (1) no. above ground treated water tank of RCC construction (RCC work in BHEL scope) complete with all instrumentation and accessories & of minimum retention time of 8 hours located in STP area.

3.1.34 Two (2) nos.(1W+1S) horizontal centrifugal type treated water disposal pumps for treated water tank complete with all instrumentation, valves, piping etc.

3.1.35 One (1) no. below ground sludge sump (RCC work in BHEL scope) complete with all instrumentation and accessories.

3.1.36 Two (2) nos.(1W+1S) vertical screw type sludge transfer pumps for sludge sump complete with all instrumentation, valves, piping etc.

3.1.37 One (1) no. (1W) centrifuge of MOC MSEP/CI and wetted parts of SS-304.

3.1.38 One (1) no. Poly-electrolyte dosing tank (MOC: PVC) of min 500 ltr. storage capacity for dosing chemical to centrifuge feed line complete with instrumentation, dissolving basket and slow speed (100-200 rpm) agitator of SS-316 construction. MOC of dissolving basket will be SS-316.

3.1.39 Two (2) no. Poly-electrolyte dosing pump (MOC: PP), capacity to suit, along with instrumentation and accessories as per P&ID of sewage treatment plant.

3.1.40 1 no. sludge handling trolley for manual disposal of sludge cake.

3.1.41 Required Piping for transferring Centrate from centrifuge outlet to equalization tank along with necessary valve, fitting & flanges.

3.1.42 Required Piping for transferring waste water generated from dual media filter & activated carbon filter to common sewage collection sump/ equalization tank along with necessary valve, fitting & flanges.

3.1.43 Required Piping for transferring over flow of hypo- contact cum filter feed tank to plant drain along with necessary fitting & flanges.

3.1.44 Required Piping for transferring over flow of treated water tank to plant drain along with necessary fitting & flanges.

3.1.45 Piping required for sludge recirculation line along with valves from the outlet of sludge transfer pumps to MBBR tank along with necessary valve, fitting & flanges.

3.1.46 Piping required for transferring treated water through treated water disposal pumps to horticulture network (500 m) along with necessary valve, fitting & flanges.

3.1.47 Piping required for transferring sewage from sewage sump S1 to sewage sump S2 along with necessary valve, fitting & flanges.

3.1.48 Piping required for transferring sewage from sewage sump S2 to sewage sump S3 along with necessary valve, fitting & flanges.

3.1.49 Piping required for transferring sewage from sewage sump S3 to common sewage collection sump located in STP area along with necessary valve, fitting & flanges.

3.1.50 Piping required for transferring sewage from sewage sump S9 to sewage sump S8 along with necessary valve, fitting & flanges.

3.1.51 Piping required for transferring sewage from sewage sump S8 to sewage sump S7 along with necessary valve, fitting & flanges.

3.1.52 Piping required for transferring sewage from sewage sump S12 to sewage sump S11 along with necessary valve, fitting & flanges.

3.1.53 Piping required for transferring sewage from sewage sump S11 to sewage sump S7 along with necessary valve, fitting & flanges.

3.1.54 Piping required for transferring sewage from sewage sump S10 to sewage sump S7 along with necessary valve, fitting & flanges.

3.1.55 Piping required for transferring sewage from sewage sump S7 to sewage sump S6 along with necessary valve, fitting & flanges.

3.1.56 Piping required for transferring sewage from sewage sump S6 to sewage sump S4 along with necessary valve, fitting & flanges.

3.1.57 Piping required for transferring sewage from sewage sump S5 to sewage sump S4 along with necessary valve, fitting & flanges.

3.1.58 Piping required for transferring sewage from sewage sump S4 to common sewage collection sump located in STP area along with necessary valve, fitting & flanges.

3.1.59 Piping required for transferring sewage from sewage sump S13 to upstream sump/common sewage collection sump located in STP area along with necessary valve, fitting & flanges.

3.1.60 Necessary piping, valves, fitting, instruments etc. As per P&ID for sewage treatment plant enclosed with this technical specification.

3.1.61 There shall be **4 NOS OF SEPTIC TANKS*** as per location indicated in layout drg attached as part of specs. The quantum of sewage generated at the isolated locations of the plant being minimal shall be collected in the respective manholes and finally flow to the septic tanks (Civil works by BHEL) by gravity wherein the partial treatment shall be provided, and partially treated sewage shall be treated with online hypo dosing prior to being reused in the nearby areas for horticulture.

Treated water disposal pumps (1W+1SB), valves, piping, instrumentation, etc required for each septic tank area shall be in scope of supply of bidder (i.e. 4 sets).

All necessary dosing tanks, dosing pumps (1W+1SB), valves, piping, instrumentation, etc required for each septic tank area shall be in scope of supply of bidder (i.e. 4 sets).

***If Septic Tank is not acceptable due to statutory requirements, bidder to provide alternate equivalent system/ arrangements in place of septic tanks/dosing/transfer pumps etc arrangement mentioned above without any cost implication.**

3.1.62 The scope of supply and erection shall include all interconnecting piping, fittings, supports, valves, instruments etc.

3.1.63 The MBBR based sewage treatment plant operation & control (located inside STP area) shall be carried out through Relay based control system. Relay based control desk shall be provided with coloured Mimic, H.W. Annunciator, P.B., Indicators, indication Lamps and Ammeters. located inside STP area.

3.1.64 Sewage transfer pumps installed in various sewage lifting sumps (S1, S2, S3, S4, S5, S6, S7, S8, S9, S10, S11, S12 & S13) located outside boundary of STP area shall be controlled through self-standing local control panel. Self-standing local control panel shall be in bidder's scope. Redundancy of instruments shall be provided by bidder as per requirement spelled in **Section-C3** (SPECIFIC TECHNICAL REQUIRMENT- C&I).

3.1.65 Bidder to take care the length of piping as indicated in plot plan/elsewhere in specification of sewage treatment plant. Pipe routing shall be decided during detailed engineering, however bidder will consider 6 m static head + 10% margin (or as per grade level of respective sewage collection sump location as indicated in the attached drg in tender specs) during pump selection for outside STP area and treated water disposal pumps.

3.1.66 The pipes from the individual sewage lifting stations/ sewage sumps (S1, S2, S3, S4, S5, S6, S7, S8, S9, S10, S11, S12 & S13 located outside STP area) to common collection sump located in STP area shall be routed on pedestals/buried. Further treated water piping from treated water disposal pumps (located in STP area) to horticulture network area shall also be routed on pedestals/buried. For buried piping wrapping, coating and protection is in bidder's scope & shall be as per IS-10221.

3.1.67 The pipe inside STP area shall be preferably run on pipe pedestals. 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. If buried piping is required, wrapping, coating and protection of all the buried pipe is also in bidder's scope & shall be as per IS-10221.

3.1.68 All steel inserts plates with lugs, rungs, ladder, puddle pipes, bolts, edge angle in desired shape, nuts, sleeves, and all other embedding components etc. as required to grout in BHEL civil works and to support/hold the equipment being supplied under this specification shall be in bidder's scope.

3.1.69 Any statutory clearance required for the system from MOEF or local pollution control board/ local authorities/ CPCB's (Central Pollution Control Board) latest regulatory requirement prevailing at the time of execution of the contract, is in bidder's scope. **Bidder shall give detailed calculations in support of meeting the specified outlet water quality (as per applicable statutory requirements or as specified, whichever is stringent), with supporting backup which shall be subject to approval of BHEL/Customer.** Bidder to also note that the sizing of STP (System, MBBR tank, etc) shall be subject to approval during detailed engineering Requirements/ supply of any necessary equipment/instruments to meet/comply to statutory obligations is in bidder's scope.

For Sewage treatment plant, required/necessary EQMS instruments (not limited to, but including anlaysers for pH, BOD, COD, conductivity, oil in water, TSS) shall be provided by bidder with provision for bidirectional connectivity over ModBus/RS-232/RS-485 with Employer's central cloud server/EQMS for real time data monitoring, remote diagnostics & remote calibration checks, etc. All necessary hardware and software required at instrument end shall be provided by the Bidder. The finally treated sewage shall meet the norms of environment protection rules 1986 and its amendments and the rules of State Pollution Control Board.

3.1.70 The Bidder's scope includes all the first fill and one year's topping, requirements of consumables such as oils, lubricants including grease, servo fluids, gases, etc. Consumption of all these consumables during the initial operation or carrying out performance guarantee test of bidder's supplied equipment (whichever is later) and final filling after the initial operation OR carrying out performance guarantee test at site (As applicable) of bidder's supplied equipment (whichever is later) shall also be included in the scope of the Bidder. Bidder shall also supply a quantity not less than 10% of the full charge of each variety of lubricants, servo fluids, gases, etc. used which is expected to be utilised during the first year of operation. This additional quantity shall be supplied in separate Containers. 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.

3.1.71 The pipe sizes indicated in the tender specification/ P & I diagram are minimum. Wherever pipe sizes are not indicated, the same shall be selected based on the specification requirement and shall be subject to BHEL / customer approval during detailing engineering. All pipes shall be carbon steel unless exclusively mentioned.

3.1.72 All necessary drains, vents and sampling points with valves as specified and as required are in bidder's scope.

3.1.73 Monitoring gadgets, instruments and equipment required for maintenance (till carrying out performance guarantee test at site (As applicable) & plant handover.

3.1.74 Associated piping, instrumentation and valves required for the system.

3.1.75 All necessary instruments and controls required for easy and safe operation of the system.

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

3.1.77 All pipes, fittings etc. Required for hand railing, platforms, and ladders shall be in the scope of bidder. All ladders shall be non-civil work. All insert plates, nuts and bolts, counter flanges wherever Applicable shall be in the scope of bidder. Supply and erection of hand railing as desired for safety purpose will be in bidder's scope.

3.1.78 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.

3.1.79 Instrumentation, valves etc. Indicated in P & ID of sewage treatment plant are bare minimum requirement, however bidder has to provide complete system for trouble free operation meeting technical specification requirement.

3.1.80 Sewage sumps S1, S2, S3, S4, S5, S6, S7, S8, S9, S10, S11, S12 & S13 shall be located outside STP area however rest facilities indicated in P & ID of STP shall be located inside STP area provided in plot plan included in this specification.

3.1.81 All blank flanges/counter flanges, isolations valves, tees etc. to interconnect the pipes at all terminal points.

3.1.82 13 nos. Chain pulley block / electrical hoist for handling of sewage transfer pumps located outside STP area provided sewage lifting sumps (S1, S2, S3, S4, S5, S6, S7, S8, S9, S10, S11, S12 & S13).1 no. Chain pulley block / electrical hoist for handling of common collection sump sewage transfer pump. 1 no. chain pulley block/ Electrical hoist for handling of MBBR feed pumps. 1 no. chain pulley block/ Electrical hoist for handling of Vertical screw sludge transfer pumps. 1 no. chain pulley block/ Electrical hoist for handling of filter feed pump & treated water disposal pumps. 1 no. electric hoist for handling of centrifuge. Selection criterion of chain pulley block/ electric hoist shall be as per ELECTRIC HOIST AND MANUAL HOIST (CHAIN PULLEY BLOCK) specification defined elsewhere in this tender technical specification.

3.1.83 Media, bar screen chamber, oil & grease trap, media for MBBR tank, media for Tube settler, media for dual media filter, media for activated carbon filter & air grid arrangement for common collection sump, equalization tank, MBBR tank & Sludge pit.

3.1.84 PIPING

a) Complete piping indicated in P & ID of Sewage treatment plant is in bidder's scope of supply and erection. In addition, any additional piping required to make the system complete inside STP area shall be in bidder's scope. Pipe length inside STP area has to be considered by bidder in their scope as per approved equipment layout and piping layout during detailed engineering. The below indicated pipes shall be designed, supplied, erected, laid and tested by the bidder. Elbows, tees, flanges, counter flanges, Hangers and supports, embedment plates with lugs etc. required for the below given piping shall also be provided by the bidder.

b) Pipe distances from sumps outside STP area up to STP area are given below:

SL. NO.	FROM	TO (Also refer P&ID)	Distance (In meters)
1.	Sewage sump (S1)	Sewage sump (S2)	190
2.	Sewage sump (S2)	Sewage sump (S3)	130
3.	Sewage sump (S3)	Common collection sump	405
4.	Sewage sump (S9)	Sewage sump (S8)	300
5.	Sewage sump (S8)	Sewage sump (S7)	335
6.	Sewage sump (S12)	Sewage sump (S11)	270
7.	Sewage sump (S11)	Sewage sump (S7)	530

8.	Sewage sump (S10)	Sewage sump (S7)	400
9.	Sewage sump (S7)	Sewage sump (S6)	250
10.	Sewage sump (S6)	Sewage sump (S4)	505
11.	Sewage sump (S5)	Sewage sump (S4)	170
12.	Sewage sump (S4)	Common collection sump	240
13.	Sewage sump (S13)	To nearest Sewage sump	200

Bidder to note that no commercial settlement / adjustment shall be entertained for variation up to +/- 5% of pipe lengths tabulated above during detailed engineering.

Bidder to note that above piping distances are in bidder's scope. Distances given above are from one area to other area only, however inside piping in respective area shall be in bidder's scope which is not included in above distances. Layout and routing shall be finalized during detailed engineering. However, system shall be designed to take care of any increase or decrease in length of piping.

c) Piping from treated water disposal pumps up to horticulture network 500 meters shall be in bidder's scope. Layout and routing shall be finalized during detailed engineering. However, system shall be designed to take care of any increase or decrease in length of piping.

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

3.1.85 Mandatory spares as per attached Annexure-V of Section C1 to this technical specification.

3.1.86 Special tools and tackles as required for the system.

3.1.87 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.

3.1.88 Start-up and commissioning spares as required.

3.1.89 Instrument air piping (after BHEL terminal point) along with necessary valves, instrumentation, fitting & flanges to meet the system requirement shall be in bidder's scope.

3.1.90 Supply of handrail material & erection of the same shall be in bidder's scope.

4.0 ADDITIONAL REQUIREMENT

4.1 Operating platforms, ladders, supports and other structural works for each sump/tanks as well as dosing equipment etc. for sewage treatment plant to facilitate accessibility for operation and maintenance is also in bidder's scope.

4.2 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.

4.3 All required elbow, tee, pipe fittings etc. required for erection of the complete system including piping shall be in bidder's scope. Bidder to provide the detailed BOQ shall be derived during detail engineering. Bidder to consider 10% margin over and above the BOQ requirement of all the fittings.

4.4 All the pipes outside STP area shall preferably be below ground (buried). For pipes running in STP area 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.

4.5 Bidder shall consider 6 m static head + 10% margin (or as per grade level of respective sewage collection sump location as indicated in the attached drg in tender specs), in addition to the losses in straight pipes and bend in pipes, tees, reducer, expander and valves etc. while selection of pump head during detailed engineering.

4.6 On completion of erection, a complete list of bearings/ equipment giving their location and identification marks shall be furnished to the Owner along with lubrication requirements.

4.7 MCC, Relay based control room & battery room shall be located in STP area building. All Sewage treatment facilities and chemical dosing facilities shall be located in Sewage treatment plant building. Further for all pumps located outside building shall be provided with localised canopy arrangement on pump & motor and the same shall be in bidder's scope.

4.8 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.

4.9 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.

4.10 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.

4.11 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.

4.12 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.

4.13 Wherever CIVIL works is excluded from the bidder's scope, 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 successful bidder for concurrence. 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".

4.14 All necessary valves and fittings for the installations with the actuators necessary for their remote operation.

4.15 Embedment plates with lugs shall also be provided by bidder as per system requirement.

4.16 All channels & brackets, mounting plates as required for mounting of motors, pumps, stirrers, tank etc. shall be in bidder's scope.

4.17 All necessary structural steel for pipe supporting structure, platforms, walkways / pathways and access stairs, mechanical plant and equipment, mechanical services and pipe work associated with STP Plant.

4.18 All handrails shall be of 32 mm nominal bore MS pipes (medium class) as per IS: 1161 galvanized using 750 gm/sq. m of zinc. Hand railing shall be a two-rail system with the top rail 1000 mm above the walkway surface and the intermediate rail 450 mm below the top rail. Handrail post spacing shall be limited to 1500 mm as far as possible but can be proportioned to the length of the opening. In such a case spacing shall not exceed 1850 mm centre to centre of posts. Hand railing shall be shop fabricated for specific locations and field welded or bolted to the erected structural steel. Railings shall be provided with 100 mm wide and 8 mm thick MS strip at bottom as toe guard all along the length of railing in horizontal plane. For RCC stairs, hand railing with 20 mm square MS bar balustrade with suitable MS flat and Aluminium / Teakwood handrail shall be

provided, unless specifically mentioned otherwise.

4.19 Instrument hook up material shall be in bidder's scope.

4.20 Permanent ladder (not rungs) for approaching the top of tanks, valves for All steel inserts 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 equipments being supplied under this specification for opening/maintenance purpose.

4.21 Wrapping, coating and protection of the entire buried pipe shall be as per IS 10221 or AWWA C 203-93.

4.22 Any item/work either supply of equipment or erection material which have not been specifically mentioned in but are necessary to complete the woks for trouble free and efficient operation of the plant shall be deemed to be included within the scope of this specification and shall be in bidder's scope without any commercial, technical and delivery implication to BHEL.

4.23 All other items are also included in scope of supply as specified in other part of the specification.

4.24 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.

5.0 ELECTRIC HOIST AND MANUAL HOIST (CHAIN PULLEY BLOCK)

Required number of electric hoist / manual hoist of adequate capacity, to meet the erection and maintenance requirements are to be provided for the various areas.

Bidder to note that chain pulley block shall be manufactured as per class-II of IS3832 & Electric hoist shall be manufactured as per class-II of IS-3938.

The stipulations of all statutory codes like Indian Electricity Act, Indian Electricity Rules, Factory Acts, Local Municipality act etc. shall however prevail over the specification requirements, in case any conflict arises between this specification and the statutory codes.

Maintenance tools and tackles shall be as per data sheet attached.

5.1 DESIGN CRITERION FOR ELECTRIC HOIST AND MANUAL HOIST (CHAIN PULLEY BLOCK)

For items weighing 300 kg and above, hoists and trolleys along with monorails shall be provided throughout the plant where crane cannot be utilized. For items weighing less than 1000 kg, manual hoists shall be provided. For items weighing 1000 kg and more, electric hoists (lift & travel) shall be provided. In case the lifting height is more than 10m, electric hoist (lift & travel) shall be provided irrespective of the weight. All hoists shall be provided with trolleys.

Capacity of cranes & hoists shall be selected considering a minimum margin of 25% over the maximum weight of the heaviest equipment / component to be handled by the Crane/Hoist.

For hand operated hoists, the hoists shall be suitable for operation from floor level. Hand chain shall be provided for long travel of trolley and the Hoisting mechanism. The operator shall be able to control the movement of the electrical/ manual hoist with the help of floor operated pendant.

5.2 SCOPE OF SUPPLIES

Equipment and services to be furnished by the bidder for the ELECTRIC HOIST/ MANUAL HOIST with accessories as per the details given in the technical specification and data sheet A. Any equipment /accessories not specified in the specification but required to make the ELECTRIC HOIST/ MANUAL HOIST complete and efficient operation shall also be under the bidder's scope of work.

Compliance with this specification shall not relieve the bidder of the responsibility of furnishing material and workmanship to meet the specified working/duty conditions.

5.2.1 Electric hoist shall include but not be limited to the following: -

a. Hoisting and CT drive arrangement
b. All electrical equipment including cables (as per electrical scope matrix) and panels.
c. PVC insulated shrouded bus bar DSL
d. Earthing arrangement.
e. Initial fill of lubricant.
f. Painting of electric hoist and accessories.
g. Maintenance Tools & Tackles (as per attached list)
h. Erection & Commissioning spares
i. Isolating switch in enclosure at operating floor for disconnecting supply to DSL while maintaining the electric hoist.

5.2.2 Erection and Commissioning spares (ELECTRIC HOIST)

The Bidder shall also supply erection & commissioning spares along with his main equipment as per his experience, for replacement of damaged or unserviceable parts during the execution of the project at site, to avoid delay in the project schedule. This shall form part of the main equipment supply. The Purchaser shall retain the unutilized commissioning spares. The initial fill of lubricants, oil etc. shall also be supplied by the bidder.

5.2.3 Services to be provided by the bidder

Packing, forwarding and transportation to site, storage and handling at site.

5.2.4 Erection and Commissioning

5.2.5 Functional test (Overload testing, load testing at rated speed, travel and hoisting motion checks as per relevant Indian standards).

5.2.6 Obtaining clearance and acceptance certificate from the concerned competent authority after site test as applicable. Necessary fees/expenditure as required shall be borne by the bidder.

5.3 INSPECTION AND TESTING

As per enclosed reference quality plan and as per IS 3938 (latest revision). Prime inspection agency shall be Consultant/ End Customer. Equipment supplied shall be strictly in accordance with nomenclature & technical specification. Any additional testing requirement/CHP (Customer Hold Point) at any stage of inspection deemed necessary by Consultant/ End Customer during detailed engineering shall be carried out without any commercial or technical implication.

5.4 TESTING AT VENDOR'S WORKS

Hoist along with its drives, controls and other accessories shall be demonstrated for the rated capacity against the rated speed of motions and for the service conditions specified as specified in QAP and as per IS 3938 for electric hoist and IS 3832 for manual hoist.
The bidder shall have the full responsibility for the safe and efficient operation of the hoist with associated accessories as a single unit.
If the shop performance tests indicate the failure of any of the components to achieve the guaranteed performance, the deficiency shall be made good at bidder's cost.
Demonstration tests shall be carried out each time after the rectification /modification is carried out.

5.5 MAKE OF SUB - VENDOR ITEMS

Makes of bought out items will be as per list specified in the specification. Make shall be subject to BHEL / UPRVUNL approval, during detailed engineering. (Refer annexure-II)

5.6 TESTING AT SITE

A) ELECTRIC HOIST:
As required for statutory clearance for operating at site i.e., overload test, load test and other tests as per IS 3938.

Test for Operation -After the supply has been connected, tests shall be carried out to prove the following:
a) The satisfactory operation of each controller, switch, contactor, relay and other control devices and in particular, the correct operation of all limit switches under the most unfavourable conditions;
b) The correctness of all circuits and interlocks and sequence of operation; and
c) The satisfactory operation of all protective devices.

Overload Test -After test but before the hoist is put into service, it shall be tested with overload relays appropriately set, to lift and sustain a test load of 125 percent of the working load. During the overload test, the hoist shall sustain the load under full control. The specified speeds need not be attained but the hoist shall show itself capable of dealing with the overload without difficulty.

B) MANUAL HOIST:
As required for statutory clearance for operating at site with following minimum test i.e., overload and load test.

5.7 MAINTENANCE TOOLS AND TACKLES

One (1) complete unused new set of special purpose tools, tackles and accessories along with detailed instructions and maintenance manual shall be supplied. Tools shall be of suitable sizes for maintenance of electric hoist of each type and capacity. Each tool and wrench shall be stamped so as to be identified easy for its use. The tools shall be supplied in steel toolbox and with a copy of instruction manual. The items supplied shall be of the best quality, specially protected against rusting.

The following shall be provided as minimum requirement:

S-No.	Description	Qty.
1	Complete set of ring spanners (Indicate the sizes offered)	1 Set
2	Complete set of screwdrivers (Indicate the sizes)	1 Set
3.	Adjustable Spanner	1 No.
4.	Insulated plier	1 No.
5.	Grease gun	1 No.
6.	Oil gun	1 No.
7.	Line tester	1 No.

Note: -The tools shall be supplied in one tool box. Bidder shall ensure that the tools & tackles mentioned in above list are sufficient to handle all sizes/capacities of hoists & in case any other /additional tool is required for handling/maintenance any size/capacity of hoist the same shall be included in this list.

5.8 ELECTRICAL REQUIREMENTS

Electrical equipment shall be adequately rated to permit simultaneous operation of any combination of motions of the crane for it duty service.

5.8.1 MOTORS

Motor ratings shall be 25% (at least) over the maximum power requirement. The hoist motors shall be rated to lift 125% of the design load at rated speed.

Motors shall suit the duty class S4, cyclic duration factor 60% and 300 starts per hour and shall be suitable for VVF operation. Motor pull out torque shall not be less than 2.75 times/ rated torque. Motor shall have class F insulation temperature rise limited to class B and enclosures shall conform to the degree of protection IP-55.

All motors shall be capable of the following:

- Operating satisfactorily at full load for 5 minutes without injurious heating with 75% rated voltage at motor terminals.
- Withstand 120% of rated speed for two minutes.
- Current shall not exceed 6 times full load current for creep speed motor.
- Withstanding the stresses imposed if started at 110% rated voltage.
- Start with rated load and accelerate to full speed with 80% rated voltage at motor terminals.

- The locked rotor motor withstand time under hot condition at 110% rated voltage shall be more than motor starting time at minimum permissible voltage by at least 3 seconds for motors upto 20 seconds starting time.
- Maximum torque shall not be below 200% of full load torque.

Each motor more than 30 KW rating shall be provided with space heater. All electrical equipment accessories and wiring shall have tropical protection.

The VVF drive control shall be used for control of each motion. The VVF drive shall be equipped at least with 1024 pulse in card, droop control for synchronization and crane software. The rating of VVF shall be decided considering 250% of full load current of respective drive motor based on in panel rating with derated at 50 Deg C ambient temperature.

The crane(s) shall be furnished complete with all electrical equipment, accessories, like drive motors with VVF drives, conductors, insulators, protective & operating devices, cables, current collectors, all protective devices, anti-collision limit switches, mechanical overload and protection for electrical faults etc.

5.9 DSL

DSL shall meet the following requirements:

- Shrouded bus bar type.
- Minimum 20% allowance for wear and tear shall be considered during sizing.
- Voltage drop for all conductors and cables/ wires shall be limited to 3% of rated voltage between the main disconnect witch and motor terminals.

5.10 LIMIT SWITCHES

The limit switches shall be totally enclosed type IP-55. Each hoist shall be furnished with two (2) limit switches meeting the following requirements:

- A screw type limit switch with self-resetting features which will act in case of over hoisting.
- A gravity operated hand reset type limit switch as a backup protection against over hoisting. Track type limit switches shall be provided on the bridge and trolley to prevent over travelling in either direction.

Trailing cable shall be 1100 V grade, tinned copper, heat resistant, with EPR insulation and as per Class – 5 of IS-8130. Also should have inner PCP sheath and outer CSP sheath with nylon cord reinforcement & heat resistant, oil resistant and flame retardant heavy duty FRLS type.

5.11 CONTROL & INSTRUMENTATION REQUIREMENTS

Necessary start/stop and emergency controls shall be provided. Automatic reset type limit switches shall be provided to prevent over-travel for-

a) Over hoisting and lowering motions of the hook.
b) Long travel motion
c) Cross travel motion

OPERATING SPEEDS FOR MISCELLANEOUS HOISTS

a. Hoist	: 3 m/min
b. Trolley travel	: 6 m/min
c. Long travel	: 10 m/min
d. Creep speed	: 10% of full speed (as applicable)
e. Crane runway rails	: Rails to suit

Notes:

1. Area, type, capacity mentioned are minimum requirement and shall be finalized during detail engineering without any commercial implication.
2. Travel and Lift are layout dependent and shall be finalized during detail engineering without any commercial implication.
3. Additional electric/manual hoist required during detail engineering shall be provided as per design criteria given above without any commercial implication.

6.0 SCOPE OF SUPPLY FOR ELECTRICAL

The scope of electrical works, equipment and services shall be as Section C2 included in specification. Other electrical design details shall be as per section D of the technical specification.

7.0 SCOPE OF SUPPLY CONTROL AND INSTRUMENTATION

7.0.1 Minimum instrumentation as per PE-DG-426-673-A001, however bidder will provide all necessary instrumentation for safe and trouble free operation.

7.0.2 Other control and instrumentation design details are specified in specification section C3/D.

8.0 SCOPE OF CIVIL

The CIVIL works is excluded from the bidder's scope. 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 successful bidder for concurrence. 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".

All insert plates with lugs, puddle pipe, angle, edge angle in shape as desired for edge protection of RCC structures, rung ladders, hand railing, pumps channel, bolts, nuts, gaskets etc as required to grout in BHEL civil works and to hold / support the equipments being supplied under this specification for the STP shall be in the scope of bidder.

9.0 QUALITY ASSURANCE PLANS AND SUB VENDOR LIST

1) The quality assurance plan is enclosed as **QUALITY PLAN FOR WATER TREATMENT PACKAGE (Sewage Treatment Plant) IN 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 in Section-C1 is indicative only and is subject to approval / acceptance by customer (UPRVUNL). 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.

10.0 TERMINAL POINTS

10.0.1 Service water line (50 NB) will be provided by BHEL at 5 m distance from STP area. Further distribution in STP will be in bidder's scope. Bidder to note that pressure available at terminal point for service water will be around 2 kg/cm2; hence bidder will take care for their pump lubrication accordingly.

10.0.2 Potable water line (40 NB) will be provided by BHEL at 5 m distance from STP area. Further distribution in STP will be in bidder's scope.

10.0.3 500-meter pipeline will be provided by the bidder at clear water pump discharge with isolation valve for horticulture purpose.

All the piping shall be in bidder's scope. The pipes shall be designed, supplied, erected, laid and tested by the bidder. Elbows, tees, flanges Hangers and supports, embedment plates with lugs etc required for the below given piping shall also be provided by the bidder. In addition, any additional piping and associated accessories required to complete the system shall be in bidder's scope.

11.0 PAINTING

Painting shall be as specified in "Surface Preparation & Painting" Sec-D of this technical specification.

Internal painting of the equipments shall be suitable for withstanding effect of sewage and mixed liquid suspended solids. Outer painting shall be as per technical specifications. Supporting documents shall be furnished in support of suitability of the lining offered for the duty conditions by bidder during detailed engineering.

12.0 SCOPE OF SERVICE

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

12.1 Erection and commissioning unloading, storage and handling at site.

12.2 Arrangement of all instruments, reagents, monitoring gadgets for monitoring, & lab facilities to carry out, pre-commissioning, trial run, commissioning and Performance guarantee test/Demonstration test.

12.3 Complete grouting for equipments, fixing and any concreting inside the tanks and lining.

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

12.5 Trial run for requisite period.

12.6 Demonstration/ Performance Guarantee test.

12.7 Painting shall be as specified in "Surface Preparation & Painting" Sec-D 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.

12.8 Final touch up paint at site.

12.9 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.

13.0 EXCLUSIONS

13.1 Service air up to the terminal point.

13.2 Instrument air up to the terminal point.

13.3 Service water up to terminal point.

13.4 Firefighting facilities.

13.5 All chemicals.

13.6 All civil works including excavation, backfilling & foundation of equipment. However complete grouting for equipment, fixing and any concreting inside vessels and lining shall be in the scope of the bidder.

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.

14.0 DESIGN /CONSTRUCTION

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

The P&ID for Sewage Treatment Plant (Dwg.No.- PE-DG-426-673-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.

1.0 GENERAL DESCRIPTION

The function of the Sewage Treatment Plant is to collect all sanitary sewage originating in the plant, perform treatment and transfer the treated water for horticulture / irrigation. Sewage treatment in general carried out to reduce the solid contents of the sewage, and change the character of the sewage so that it can be reused.

Sanitary wastes are collected from the buildings that contain sanitary facilities by gravity. Sanitary lift stations shall be used to forward the waste to an onsite sewage treatment plant. Solid wastes shall be hauled offsite.

2.0 LIFT STATIONS

Each lifting station will have single compartment. Two pumps will be located on each lift station as shown in the Sewage Treatment Plant – P&ID enclosed with technical specification.

3.0 SIZING CRITERIA

Average design flow shall be 40 Cum/day. ***However, bidder to design the equipment for peak load requirements also as per CPHEEO manual requirements.***

4.0 BASIS

Sewage treatment plant shall be designed for inlet and outlet quality of sewage by the bidder. Further Zero discharge condition must be achieved within the plant boundary.

4.1 SEWAGE QUALITY INLET TO SEWAGE TREATMENT PLANT

Sewage Treatment Plant is designed for the following sewage flow rate and characteristics:

Flow Rate	:	40 M^3/day
pH	:	7.0 – 8.0
BOD	:	300 ppm
COD	:	600 ppm
Oil & Grease	:	50 ppm
Coliform count	:	10^6 to 10^7
TSS	:	300 ppm
NH4-N	:	As actual
N Total	:	As actual
Temperature	:	Ambient

4.2 SEWAGE TREATMENT OUTLET QUALITY

Treated sewage will conform to the following quality standards, however the treated sewage water qualities shall have to meet the all applicable statutory requirement also, whichever is stringent.

pH	:	7.5 – 8.5
BOD	:	Less than or equal to 20 ppm
COD	:	Less than or equal to 100 ppm
Oil & Grease	:	Less than or equal to 5 ppm
Coliform count	:	Less than or equal to 100 MPN / 100 ml
TSS	:	Less than or equal to 20 ppm

NH4-N	:	Less than 5mg/l
N Total	:	Less than 10mg/l
Residual chlorine	:	Not exceeding 0.5 mg/l
Temperature	:	Ambient

NOTES: -

The treated sewage quality standards shall be achieved at average sewage flow rates as well as peak sewage flow rates.

4.3 PIPING

All piping within the sewage treatment plan shall be in bidder's scope. Piping and valves shall be sized and rated based on flows and pressures at full-capacity operation. Piping conveying high levels of suspended solids shall be sized to maintain a minimum velocity of 0.6 m/s at the minimum flow rate to prevent solids from settling in the piping.

Pressure drops in pipes will be based on Hazen Williams's formula.
Pipe handling sewage will be Spun CI pipes (IS:1536) and air application of MOC GI only. Filtered Water & service water shall be IS-2062 Gr. B/ASTM-A-36/ASTM A-53 type 'E' Gr. B/IS-3589 Gr. 410/IS-1239 Heavy, 150 NB & above pipes shall be spiral welded. Rubber lining is to be provided as indicated in in P & ID.

Pumps will be sized based on the following:

Capacity: System requirement + 10% margin
Head: System requirement + 10% margin on friction losses.

5.0 PROCESS DESCRIPTION

The sewage treatment plant shall be designed as per guidelines of CPHEEO Manual. The anticipated no. of users shall be 1000 persons. The sewage treatment plant shall be designed to handle a flow of 40Kld considering average per capita consumption of 45lpcd with 80% of used water generated as sewage.

The Sewage Treatment Plant treatment scheme shall be modular type based on MBBR (Moving Bed Bio Reactor) technology followed by disinfection by Hypo and necessary tertiary treatment prior to reuse in horticulture purpose. Aerobic biological sludge generated shall be thickened in the tube settler and aerobically digested/dried in a sludge sump and then transferred to filter press. The dry sludge shall be disposed manually by Customer. The Process Flow Diagram / P & ID is enclosed for reference.

The sewage treatment plant shall consist of following treatment components:

1) **Pre-Treatment,** which consists of raw sewage collection and pumping & screening of incoming sewage & oil & grease removal from the collected sewage.

Preliminary Treatment:

- Coarse screens for screening incoming sewage
- Oil & Grease Trap
- Equalization cum holding tank

2) **Biological Treatment,** comprising of aeration followed by clarification and Dosing of sodium hypochlorite in the hypo contact cum filter feed tank.

Aeration System:

- Aerobic Biological treatment in the MBBR Tank with fine bubble diffused aeration.
- Transfer of treated partially treated sewage to the Clarification system.

Clarification System:

- Settling of digested sludge in the Tube Settler.
- Transfer & storage of clarified water to the Hypo Contact Cum Filter Feed Tank.
- Dosing of Sodium Hypochlorite in the Hypo Contact Cum Filter Feed Tank.
- Dosing of Sodium Hypochlorite in sludge feed line to centrifuge.

3) Sludge Handling System

- Transfer of sludge to the sludge sump from MBBR tank & tube settler.
- Transfer of sludge to centrifuge through sludge transfer pumps.
- Transfer a part of sludge to MBBR tank to maintain MLSS through discharge line of sludge transfer pumps.
- Transfer of centrate or filtrate to the equalization tank.
- Transfer of waste water generated through DMF & ACF to the equalization tank/CCS.
- Disposal of sludge as cakes by sludge trolley.

4) Tertiary Treatment:

- Polishing of treated sewage by DMF& ACF.
- Transfer of Polished sewage water for horticulture.

Detailed description of each treatment step is given below:

The various raw sewages shall be collected by gravity at local sewage lifting stations at different areas and the same to be pumped by using 2 Nos (1W+1S) Sewage Lifting Pumps to an underground common collection sump located in sewage treatment plant area.

Collected raw sewage shall be pumped from the common collection sump using 2 Numbers (1W+1S) common collection non-clog type sump Pumps to the equalization Tank after passing through the bar screen chamber & oil grease chamber provided with oil & grease trap. In bar screen chamber (MOC: RCC) the coarse screens present in the raw incoming sewage shall be subject to screening & oil & grease chamber (MOC: RCC) shall be provided with Oil & grease trap for removal of oil & grease from the raw incoming sewage.

The Sewage Lifting Pumps shall be of submersible and heavy duty grinding type which shall cut and grind solids present in raw sewage into small fragments. The Sewage Lifting Pumps shall automatically START at high level in the Sewage Collection Pit and STOP at low level.

The common collection sump shall also be provided with a coarse air bubble diffuser and an airline tapping from the Air Blower delivery header so as to allow continuous aeration in order to protect the STP Package against unpleasant odours.

2 numbers (1W+1S) Air Blowers common for common collection sump, Equalization tank & sludge sump shall be provided to supply air through an underwater piping grid and fine air bubble membrane diffusers.

2 numbers (1W+1S) vertical submersible MBBR feed pumps shall be provided in equalization tank to transfer sewage from equalization tank to MBBR reactor. 1no. MBBR reactor of MSRL construction along with 2 numbers (1W+1S) Air Blowers for MBBR tank to supply air through an underwater piping grid and fine air bubble membrane diffusers to MBBR reactor.

1 number tube settler of MSRL construction for Settling of digested sludge in the Tube Settler.

1 number of Hypo contact cum filter feed tank of MOC RCC shall be provided for storage of clarified water after clarification process. Further 1 no. hypo dosing system consists of 1 number Hypo dosing tank of MOC PVC along with 1 number hypo dosing pump shall be provided for dosing of sodium hypo chloride inside the hypo contact cum filter feed tank. Over flow connection from the Hypo contact cum filter feed tank shall be connected through pipe to plant drain.

Further 2 numbers (1W+1S) horizontal centrifugal type filter feed pumps shall be provided for feeding clarified water after clarification process for tertiary treatment through dual media filter & activated carbon filter.

1 number dual media filter & 1no. Activated carbon filter shall be provided for the tertiary treatment of clarified water after clarification process. Backwash & waste water generated from dual media filter &

activated carbon filter shall be transferred to the equalization tank.

1 number treated water tank over ground (MOC RCC) shall be there for storage of final treated water after tertiary treatment. Further 2 numbers (1W+1S) horizontal centrifugal type treated water disposal pumps shall be provided for transferring the treated water for gardening purpose.

1 number sludge sump of (MOC RCC underground) for storage of sludge generated from MBBR tank & tube settler shall be provided. 2 nos. (1W+1S) of vertical screw type sludge transfer pumps for feeding sludge from sludge sump to centrifuge. Further hypo dosing system consists of Hypo dosing tank along with hypo dosing pump shall be provided for dosing of sodium hypo chloride during feeding of sludge to centrifuge.

Sodium hypochlorite solution dosing shall be carried out into the hypo contact cum filtered feed tank & feeding line to centrifuge to control the BOD.

Further 1 number trolley mounted arrangement shall be provided for disposal of sludge cake generated from centrifuge. Centrate produced from centrifuge shall be transferred to Equalization tank.

The stabilized sludge shall be free of offensive odours.

6.0 OPERATION AND CONTROL PHILOSOPHY

The MBBR based sewage treatment plant operation & control shall be carried out from the Relay based control system (Bidders Scope). Control of sewage sumps located outside boundary of STP common area shall be through self-standing local control panel (Bidder scope).

Relay based control system for MBBR based sewage treatment plant shall be located in the STP area. However, the control of sewage lifting pumps (S1, S2, S3, S4, S5, S6, S7, S8, S9, S10, S11, S12 & S13) other than STP area shall be through self-standing local control panel.

All pumps shall be fitted with check valves and pressure gauge on the discharge side. All pump shall be tripped automatically in case of low level in the pits/tanks and shall be started manually. Annunciations for high level in pits/tanks shall be provided.

Similarly, air blowers (located at Sewage treatment plant area) shall be suitably interlocked with Relay based control system.

Number of signals / Annunciation shall be provided in control system and the same shall be decided During Detailed Engineering stage.

Note: Bidder to note that for complete control & operation of the STP plant, bidder to also refer the respective Control & Instrumentation (Section C2) & Electrical (section C3).

15.0 LAYOUT

Space requirement has been indicated in plot plan, attached with specification. All the equipment will be open to sky except control panel, hence bidder has to take care that all the equipment will be whether and dust proof. Control panel will be located in industrial shed in STP area.

16.0 DEMONSTRATION TEST

The Demonstration test shall be as per clause 4.2 above.

17.0 DRAWING/DOCUMENTS REQUIREMENT (PL REFER ELECTRICAL & C&I PORTION ALSO): -

For the Drawings/Documents submission schedule, please refer **Vol-III.**

For the Drawings/Documents Submission Procedure, please refer **Sec-C/ Sec-D**. 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.

18.0 SPARES

1. All the spares for the equipment under the contract provided by the vendor will strictly conform to the specifications and documents and will be identical to the corresponding main equipment/components supplied under the contract.

2. The quality plan and the inspection requirement finalized for the main equipment will also be applicable to the corresponding spares.

3. The list of mandatory spares considered essential by the BHEL & Customer is indicated in Annexure IV. The bidder shall indicate the prices in the 'Schedule of mandatory Spares' whether or not he considers it necessary for the BHEL & Customer 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. Whenever the quantity is mentioned in "sets" the bidder has to give the item details and prices of each item.

   The prices of mandatory spares indicated by the Bidder in the Bid Proposal sheets shall be used for bid evaluation purposes.

   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.

   Wherever quantity is specified both as a percentage and a value, the Bidder has to supply the higher quantity until and unless specified otherwise.

4. Start-up and commissioning spares are in bidder's scope of supply.

   Start-up and Commissioning spares are those which would be required during equipment or system testing, start-up and commissioning. All spares used until the plant is finally handed over by the bidder to the customer come under this category. All start-up and commissioning spares as required shall be provided by the bidder without any additional cost to the BHEL and customer.

   Bidder shall be responsible for the ready and timely availability for all the startup and commissioning spares as required during various stages of testing, cleaning and commissioning up to handing over of each unit of the total plant.

   An adequate stock of start-up spares shall be available at the site such that the start-up and commissioning of the equipment/systems, Performance guarantee test and handing over the equipment/ systems to the customer will be carried out without hindrance and delay. All start-up spares which remain unused after the taking over of the plant shall remain the property of the customer.

5. In addition to the spare parts mentioned above, the Bidder shall also provide a list of recommended spares for 3 years of normal operation of the plant and indicate the list and unit prices in Price Schedules. This list shall take into consideration the mandatory spares specified Annexure IV and should be independent of the list of the mandatory spares. The BHEL 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.

   Price of recommended spares 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. However, the Bidder shall be liable to provide necessary justification for the quoted prices for these spares as desired by BHEL.

   The vendor warrants:

(i) That all spares supplied will be new and in accordance with the contract document and will be free from defects in design, material and workmanship and shall further guarantee as under:

(ii) In case of any failure in the original component/equipments due to faulty designs, materials and workmanship, the corresponding spare parts if any, supplied will be replaced without any extra cost to the BHEL and customer unless a joint examination and analysis by BHEL and/or customer of such spare parts prove that the defect found in the original part that failed can safely be assured not to be present in spare parts.

(iii) The long term availability of spares to the BHEL and the customer for the full life of the equipment covered under the contract and that before going out of production of spare parts of the equipment covered under the contract, vendor and his sub-vendors shall give the BHEL and the customer at least 24 (Twenty Four) months advance notice so that the latter may order his bulk requirements of spares, if he so desires. The same provision will also be applicable to the sub-vendors. Further, in case of discontinuance of manufacture of any spares by the vendors or his sub-vendors the vendors and his sub-vendors, will provide the BHEL and the customer, 2 (two) years in advance, with full manufacturing drawings, material specifications and technical information required by the BHEL and the customer for the purpose of manufacture of such items and also the right to manufacture such spares for their own requirements.

(iv) Further in case of discontinuance of supply of spares by the vendors or his sub-vendors, the vendor will provide the BHEL and the customer with full information for replacement of such spares with other equivalent makes, if so required by the BHEL and the customer.

(v) Notwithstanding the above, the vendor shall be responsible for supply of spares for the lifetime of the package at reasonable prices. The prices of all future requirements of spares shall be derived from the corresponding ex-works price at which the orders for such spares have been placed by the BHEL and the customer as a part of the mandatory or long term or any other kind of spares. The base indices for calculating ex-works price shall be commissioning of last equipment under main contract.

6. The vendor will indicate the delivery period of the spares, which the BHEL and the customer may procure in accordance with this clause.

7. In case of emergency requirements of spares, the vendor would make every effort to expedite the manufacture and delivery of such spares on the basis of mutually agreed time schedule.

8. In case the vendor fails to supply the mandatory or long term or any other kind of spares on the terms stipulated above, the BHEL and the customer shall be entitled to purchase the same from the alternate sources at the risk and the cost of the vendor and recover from the vendor, the excess amount paid by the BHEL and the customer over the rates as per the contract. In the event of such risk purchase by the BHEL or the customer, the purchases will be as per the works and procurement policy of the BHEL and the customer prevalent at the time of such purchases and BHEL & the customer at his option may include a representative from the vendor in finalizing the purchases.

9. It is expressly understood that the final settlement between the parties in terms of relevant clauses of the tender document shall not relieve the vendor of any of his obligations under the provision of long term availability of spares and such provisions shall continue to be enforced till the expiry of 30 (thirty) years period reckoned from the scheduled date of completion of trial operation of the last equipment unless otherwise discharged expressly in writing by the BHEL or the customer.

19.0 ADDITIONAL REQUIREMENT

1. Engineering for this project is to be carried out in Integrated Intelligent Engineering environment at BHEL end. For Details Refer Drawing Document Submission Procedure/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. For calculation of pump head, bidder to follow the technical specification requirement. Wherever pipes are running on pipe rack, Bidder will consider 6 m static head (or as per grade level of respective sewage collection sump location as indicated in the attached drg in tender specs), in addition to the losses in straight length and bend in pipes and valves etc. 10% overall margin shall be considered, 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. Wherever CIVIL works is excluded from the bidder's scope, 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 successful bidder for concurrence. 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 DM 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. Any change arising out of any new government norms, statutory requirements during the course of execution of the project shall be complied by the bidder without any commercial implication.

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 sewage treatment plant is indicated/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. BBU shall be equal to BOQ for the package and there shall be no price and delivery implication is applicable to BHEL / customer for the same. None of the items supplied for the project as non-billable. Incomplete BBU shall not be review 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 & UPRVUNL for the complete sewage 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. Relevant requirements as per GTR, GCC, ECC & SCC.

24. 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.

25. 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.

26. 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.

27. Service water shall be available near 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 for package.

28. Capacity of monorail hoists, chain pulley blocks 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.

29. 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 Hand railing as desired for safety purpose will be in bidder's scope.

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

31. 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.

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

33. Necessary pipe, piping, fitting, valves, drains, vents, sampling etc. required for the complete Sewage Treatment Plant. Pipe racks shall be provided by BHEL wherever available, wherever pipe racks are not available, pipe shall be laid on pedestal (BHEL or vendor's scope as per civil scope sheet). However all auxiliary steel structure (U-clamps, nuts, bolts, channels etc.) for fixing pipes on pedestal or racks shall be in bidder's scope. Static head to be informed to bidder as per height of the pipe rack.

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

20.0 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

QUALITY PLAN

CHAPTER 11 : QUALITY ASSURANCE REQUIREMENTS

1.0 INTRODUCTION

1.1 The minimum Quality Assurance / Quality Control (QA/QC) requirements and the services the Contractor is expected to provide to assure "Quality Assurance" are described in this section. "Quality Assurance' is defined as the entire programme adopted by the Contractor during engineering, procurement and construction to assure conformity with the contract specifications. Quality Assurance/Quality Control procedures proposed by the Contractor should address the QA/QC requirements under the following phases of the project:

(a) Engineering
(b) Procurement
(c) Construction including commissioning and testing

1.2 Contractor shall submit documents to demonstrate that the Contractor and his sub-vendors possess, QA/QC programs meeting the requirements set forth in this section. Contractor shall prepare the quality assurance plans for all the offered equipments to cover the overall quality assurance requirements. Contractor shall submit a quality assurance plan along with the bid as per the format enclosed for all applicable equipment & systems.

1.3 The Contractor must submit an organization chart defining the permanent positions responsible for QA/QC accompanied by a brief description of each position's function and responsibility. A second organization chart along with a descriptive write up should also be provided outlining the proposed QA/QC program for this particular project. This chart and write up should identify the personnel responsible for the Engineering Quality Assurance Plan for the completion duration of the project.

2.0 ENGINEERING

2.1 Prior to finalization of contract

Prior to finalization of the Contract, the Contractor shall prepare and submit a project Quality Assurance Plan that covers the engineering phase of the Works. The plan shall be designed for this project and shall address the specifics of how the Contractor will control, monitor and verify the requirements contained in this section. The Contractor shall utilize all of his QA/QC resources, manuals and procedures when preparing the plan. Purchaser shall review the plan prior to utilization and upon issue the plan shall become the basis by which Purchaser will evaluate the Contractor's engineering QA/QC activities as they relate to this project.

2.2 Purchaser's Participation

The Purchaser reserves the right to audit and verify procedures set forth in the Engineering Quality Assurance Plan. This audit right in no way relieves the Contractor from performing the control verification procedures outlined in the plan.

2.3 Engineering Quality Assurance and Quality Control Requirements

Following are the minimum Quality Assurance and Quality Control requirements for the project. The Contractor's Engineering Quality Assurance Plan shall set forth in detail the procedures to satisfy these QA/QC requirements.

2.3.1 Design Control

The Contractor shall define, document and advise the appropriate handling of the following design controls:

(a) Establish internal as well as external discipline relationships.

(b) Qualifications of personnel assigned for each task.

(c) Establish audit procedures to ensure that the design conforms to the requirements.

(d) Define and outline the number of multi-discipline design reviews.

(e) Establish procedures for handling design changes.

(f) Establish guidelines to handle all issues in pre-award, award and pre-fabrication with Manufacturer's and Sub-contractors.

2.3.2 Document Control

The Contractor must include in its QA/QC Plan the document control procedures defining:

(a) Authorized use of documents

(b) Receipt, logging and distribution of documents

(c) Procedure for updating and implementation of additions and revisions.

(d) Procedure for document transmittal to Purchaser. Some of the requirements for document transmittal may be covered in other parts of this specification.

2.3.3 Audits

All documents shall be audited by the Contractor for conformance with the QA/QC procedures.

The Purchaser reserves the right to review design details, either directly or through their Consultants. The Purchaser may audit detailed design related design, structural/foundation designs / piping design and other areas.

2.3.4 Engineering Sub-Contractor

The subcontracting of detailed engineering to third parties does not relieve the Contractor the responsibility for Engineering Quality Assurance.

2.4 Procurement

2.4.1 Source Quality Control

It is the Purchaser's intent that the Contractor deal only with Sub-Contractors and Manufacturers (Vendors) who have established and demonstrated effective quality assurance and quality control programs. Purchaser does require, however, that the Contractor perform such normal inspection of Sub-contractors'/Vendors' work as is necessary to obtain equipment and materials conforming to the project specifications and their supporting documents (applicable codes and industry consensus standards) and good engineering, fabrication practices as described herein. Source Quality Control is also a valuable input for confirmation of delivery performance.

Minimum inspection requirements in respect of electrical and instrumentation / control equipment and civil works are covered in their respective specifications. Prior to finalization of the contract, the Contractor shall prepare and submit a Project Quality Assurance Plan that covers Procurement and a requirement for procured items for the complete Works.

2.4.2 After Award of Subcontract

Once Sub-contractors and manufacturers are established, Purchaser and the Contractor shall review item-by-item all major engineered equipment and systems and any special fabrication/fitting to reach an agreement on the need for prefabrication/pre-inspection meetings.

2.4.3 Purchaser's Participation

2.4.3.1 The Purchaser reserves the right to audit the performance of the Sub-contractors/manufacturers and the Contractors inspection effort. This is normally accomplished by visiting the Sub-contractors/Manufacturers with the Contractors' Inspector at pre-selected points during manufacture. Contractor shall identify notification points so that the Purchaser's can be present at particularly important stages of fabrication should the Purchaser wish to attend. The notification points are not hold points unless specifically identified as such. Should Purchaser elect not to or fail to attend, the Work shall proceed without interruption. The Purchaser reserves the right, however, to make announced spot-checks to facilitate evaluation of the Sub-Contractor and/or the Contractor's inspection effort. Purchaser may wish to hold technical meeting with the machinery Sub-Contractor during the design and fabrication of the machinery. Should Purchaser desire to hold technical meetings, the Contractor will be advised at a reasonable notice.

2.4.3.2 During audit visits to fabricator shops, Purchaser may elect to spot-check base materials and welds to verify proper metallurgy using whatever methods Purchaser may wish to utilize, but only in the presence of Contractor's Inspector unless otherwise agreed. Some of these requirements have been identified in the minimum inspection requirements listed in this section.

2.4.4 Communication

2.4.4.1 Direct, timely communication between the Contractor's Inspectors and Purchaser's auditing Inspectors is mandatory, especially in notification points and in the event of problems, Purchaser shall be advised in a timely manner of all situations where changes or compromises in specifications are considered or where non-conformances are being encountered. Suggested format for inspection request is enclosed with this section. The Contractor shall give advance notice of thirty (30) days for all overseas travel and fifteen (15) days for travel inside India.

2.4.4.2 Rejection reports shall be faxed by the Contractor's Inspector from works directly to Purchaser's Representative at the same time as faxed to the Contractor's home office. Reports shall be faxed to Contractor's home office for typing, editing and transmitting to Purchaser.

2.5 QA/QC Requirements

2.5.1 Inspection Plan

Inspection plans with detailed instructions for the Inspector's guidance shall be provided for each item. QA plans for the components indicated therein are enclosed in Tables 1 to 3 at end of this chapter. The Contractor shall develop the QA plans for all other equipment/systems on a similar basis as indicated in the Tables above. The Contractor's procurement Inspection function shall begin with the award of the purchase order and concludes when the Inspector (including inspection by client's inspector wherever applicable) has duly released the equipment in the Sub-contractor's shop.

2.5.2 Inspection Office

2.5.2.1 The Contractor shall identify the key inspection office located at its engineering and construction office. All inspection assignments, inspection instructions, after placement of the purchase order shall be covered from this designated office.

2.5.2.2 One individual in the Contractor's key inspection office shall be designated to fill the function outlined in 2.5.3 and must report to the Contractor's Manager of inspection. Additional staff may be added as necessary, provided they are under the supervision of the individual designated. This individual will hereafter be referred to as the "Quality Control Project Inspector (QCPI)".

2.5.2.3 For technical problems arising during manufacturing, after purchase orders are placed, the QCPI is responsible for clearing such technical problems with Engineering and/or Purchaser. All purchase orders shall have a clause requiring the Sub-Contractor to submit all questions of a technical nature concurrently to the QCPI and requisitioning Purchaser in writing through fax or letter for resolution. The QCPI shall be responsible for obtaining replies from engineering, documenting the response to the Sub-Contractor and making distribution. The assigned QCPI shall be on distribution for all other correspondence. When technical requests arise from rejection made by the Contractor's source Inspector, the source Inspector's rejection report must be attached to the Sub-Contractor's request for engineering evaluation.

2.5.3 Inspection Co-ordination and Responsibility

The QCPI shall have the overall coordination responsibility for inspection activities. The QCPI's responsibilities shall include, but not be limited to the following:

(a) Issue assignments for source inspection.

(b) Issue specific inspection instructions when required to the assigned source inspector.

(c) Indicate the required type of report forms.

(d) Coordinate and respond to questions of a technical nature.

(e) Monitor inspection reports to determine if inspections are being performed as per written instructions.

(f) Forward all related order correspondence to the assigned source Inspector.

(g) Receive inspection reports from the source Inspector and make distribution as required.

(h) Ensure that comprehensive files are maintained for each job.

2.5.4 Inspector's Qualifications

The Contractor shall submit with their QA/QC Manual resumes of contractor's inspectors detailing their experience, education and qualifications for Purchasers review/approval. The Inspectors shall have sufficient prior experience and qualifications for the equipment assigned.

2.5.5 Inspectors responsibilities

After receiving the assignment from the QCPI, the source Inspector shall review the order, conduct a pre-inspection meeting (when instructed), perform the inspections outlined, maintain field file in an organized manner and report the results to the key office and Purchaser. The following is a more detailed, but not inclusive, list of what Purchaser typically expects from the Contractor's source QCPI:

(a) Pre-fabrication meeting – the Contractor's Inspector shall conduct a pre-fabrication meeting with the Sub-contractor prior to start of fabrication. The discussion shall include, but not be limited to a review of the following items:

(i) Purchase order requirements with emphasis on any special requirements (technical and quality).

(ii) Code Requirements.

(iii) Sub-contractors Quality Control Programs.

(iv) Fabrication Schedule.

(v) Major Sub-contractors.

(vi) Welding Procedure Specification (WPS), Procedure Qualification Record (PQR) and Welder Performance Records (WPR).

(vii) Non-Destructive Examination Requirements.

(viii) Testing – Hydrostatic and Pneumatic.

(ix) Manufacturer's Data Reports.

(x) Preservation, Packing and Shipping.

(xi) Extent of Purchaser / Contractor Inspection.

(xii) Witness Points and Hold Points and Notice requirements.

(b) Initial inspection visit: The Inspector shall perform as a minimum, the following inspection activities prior to start of fabrication.

(i) Review fabrication schedule to ensure required Quality Control examinations and other intermediate tests have been included.

(ii) Establish approval of major Sub-contractors.

(iii) Verify that Welding Procedures and Procedure Qualifications have been approved.

(iv) Verify that all welders assigned to job are qualified.

(v) Review Mill Test Reports to verify materials meet specifications.

(vi) Review Sub-contractor's Examination and Inspection Plan.

(vii) Review Sub-contractor's procedure for identifying and transferring material markings.

(viii) Make a visual examination of major materials, verify Sub-contractor's examination of all materials, and verify proper storage facilities (environment and security).

(c) Progressive inspection visits: The following minimum activities, where applicable, shall be executed and reported upon by the Inspector:

(i) Monitor on a random basis the transfer of material marking throughout the fabrication.

(ii) Initial and random inspection of edge preparation, root gap and fit up for all vessel and fabricated machinery components.

(iii) Initial and random witnessing of production welding to verify approved procedures, qualified welders and proper techniques are being used.

(iv) Ensure that welding materials are being properly controlled.

(v) Inspect major weld seams, nozzle and attachment welds, overlay welding and any weld repairs.

(vi) Perform random check of back gouging of pressure retaining welds.

(vii) Inspect critical/major materials from sub-Sub-contractors.

(viii) Check nozzles / man ways for size, rating and extension.

(ix) Check dimensions and workmanship of components.

(x) Examine gaskets and bolting against specifications.

(xi) Check location and attachment welds for support clips, lugs, brackets and saddles.

(xii) Make final visual inspection for quality of work and for damage.

(xiii) Make complete dimensional inspection.

(xiv) Witness all hydrostatic and pneumatic testing.

(xv) Witness routine and special testing as may be outlined in project specifications or data sheets for Electrical and Instrumentation chapters.

(xvi) Assure electrical and instrument function and operational checks have been performed as per project specifications.

(d) Non-destructive Examination (NDE) – The Inspector shall perform as a minimum, the following NDE activities during progressive inspections:-

(i) Radiographic examination (RE)

- Review Sub-contractor's radiography procedures for approval.
- Review all radiographs progressively through out fabrication.
- Evaluate for acceptable film quality and weld quality.

(ii) Ultrasonic examination (UE)

- Review Sub-contractor's procedures and Inspector qualifications.
- Witness at least 25% Ultrasonic examinations
- Review certified results

(iii) Magnetic particle examination (MPE)

- Review Sub-contractor's procedures and Inspector qualifications.
- Witness the initial MPE examinations and 10% minimum of all MPE examinations, as well as all examinations after repair.

(iv) Liquid penetrant examination (LPE)

- Same as for MPE

(v) Hardness testing – production welds

- Review procedure and witness initial tests
- Verify 10% of hardness values during progressive inspections.
- Review all hardness readings for acceptance per specifications and require certified results.

(e) Shipping

(i) Verify that all shipping requirements related to cleaning, dry out, surface preparation.

(ii) Verify that pressure equipment is appropriately code stamped and all "Manufacturer's Certified Data Reports" are complete and properly signed.

(iii) Verify required documentation for acceptance and record is complete.

2.5.6 Inspection Reports

2.5.6.1 Inspection reports for interim inspection visits shall be consecutively numbered and identify non-conformance and exceptions found /corrected at that time. Final checklists should indicate all items inspected during interim inspections.

2.5.6.2 Inspection rejection reports shall be by telefax to the key office and Purchaser when the Sub-Contractor's proposed resolution deviates from order specifications, or would require repairing.

2.5.6.3 Final inspection reports shall be by check off for all major equipment and bulk piping components. The check off indicates the inspections were performed and would be covered on an interim inspection report.

2.5.6.4 Inspection release certificate shall be issued by the assigned Inspector only after all the requirements of the purchase order have been met. The Sub-contractor shall be given the inspection release certificate as authorization to present final billing to the Contractor and a copy of same shall be attached to the packing list to serve as notification to the job site of inspection approval.

2.6 Construction

2.6.1 Purchaser's Participation

Purchaser will have a Quality Assurance/Quality Control organization to audit the Contractor's QC effort. The assigned Purchaser's personnel will provide assurance to Purchaser's management that the Work meets specifications, however, the basic inspection and quality control responsibility is vested with Contractor.

Purchaser's auditing may include spot checks of materials including their testing in the field to ensure that inadvertent substitutions have not been made in the fabrication shops or mixing point or in field ordered materials. Purchaser's auditing shall also include testing of concrete, cement mortar, etc.

2.6.2 Communication

2.6.2.1 Direct, informal communication between the Contractor's field Inspectors and Purchaser's auditing Inspectors is mandatory. Further Purchaser shall be advised when major problems related to design or fabrication is uncovered.

2.6.2.2 Contractor's in-progress inspection reports, follow up/punch out sheets, records of radiograph inspections, etc. shall be available to Purchaser's auditing Inspectors during the course of the Works.

2.6.2.3 At the end of the Work, Contractor's standard inspection reports, check off sheets, radiographs, master copy of loop diagrams, electrical test data sheets, etc. shall be turned over to Purchaser in an organized, agreed upon format. Contractor shall verify that all of the required documentation of the equipment has been received and placed in the equipment files. The Contractor is responsible for obtaining any outstanding documentation from the suppliers.

2.6.3 Construction QA/QC requirements

2.6.3.1 It is the Purchaser's intent that the Contractor (and any Sub-contractors employed) provides sufficient qualified Inspectors to assure that facilities are installed in accordance with the plans and Purchaser's specifications and intents and that the level of quality called for therein is obtained. Prior to finalization of Contract award, the Contractor shall submit a detailed Field Quality Assurance Program for Purchaser's review. The program must be tailored to show compatibility with engineering design, compliance with applicable codes, specifications, standards, drawings, support documents, governmental regulations and this document.

2.6.3.2 For the construction period, the Contractor shall provide a full time, dedicated Quality Assurance Organization. As a minimum the Contractor's Construction Quality Assurance Program shall include the following: -

(a)**Quality Control Program**

Details of the program to be implemented, its use, control and identification of hold and inspection points shall be submitted to Purchaser for approval.

(b) **Organization, Authority and Responsibility**

Delineate the Contractor's Quality Control organization, responsibility and authority for performance of QC functions by discipline.

(c)**Inspector Qualifications**

The Contractor's Construction Assurance organization shall consist of people with qualifications similar to the requirements outlined in clause 2.5.4. The field QA organization will be a full time organization, with no other construction-related duties. As with engineering and procurement, Purchaser will review Construction QA staffing plans/

(d) **Document Control**

This system shall ensure that the latest issues of drawings, specifications, standards, and supporting documents shall be used for fabrication and installation and that field changes are incorporated into final "As Built" drawings.

(e)**Receiving Control**

Procedure for receipt of purchased items delivered at the job site initial identification, qualification and review of supporting documents shall be described. In addition, the procedure shall ensure that spare parts supplied by Contractor are properly labeled by the Sub-Contractor with description and purchase order number.

(f) **Receiving inspection**

This shall establish the method of notification and inspection to be performed on received items to verify the condition and conformance to the appropriate acceptance standards reference or contained in the purchased documents.

(g) **Sub-contractor Non-conformance**

This shall provide for documentation and disposition of non-conformances resulting from Sub-contractor errors and shipping damage to material, fabrications and equipment received at the job site. It also provides for interface with the design engineer when the non-conformance does not comply with the engineering design.

(h) **Storage and Maintenance of Materials and Equipment**

This system shall describe the controls and inspection performed to show that the handling, storage and preservation of materials and equipment are performed to prevent damage or harmful deterioration to the materials and equipment received at the job site.

2.6.5 Inspection, examination and testing of on-site fabrication and installation

2.6.5.1 This section shall establish the responsibility for performance and recording of examinations, tests and inspections as required by the engineering design.

2.6.5.2 Inspection of work in progress to determine conformance with drawings, specifications, any field definition agreed to shall be included. Some of the inspections are listed below:

(a) Soil testing

(b) Pile driving record data (if applicable)

(c) Structural concrete

(d) Performing random dimensional check and visual material verification of field fabricated pressure equipment and of any piping, vessel, electrical and instrumentation installation.

(e) Internal checking of all vessels for:

(i) Cleanliness

(ii) Proper internals. This involves opening the vessel manways and removal of internals.

(f) Witness testing and installation of items such as:

i.) Welder testing and qualifications and maintenance of records thereof.

ii.) Weld examination and maintenance of records thereof in accordance with applicable codes and specifications.

iii.) Hydrotests, hydro-pneumatic tests, pneumatic tests, lead and service tests.

iv.) Electrical inspection and testing which includes witnessing of Hipot testing, megger testing, AC power factor testing etc.

v.) Instrument model/name plate data verification

vi.) Instrument installation checkout

vii.) Instrument loop checks

viii.) Mechanical and electrical equipment bearing flushing and filling.

ix.) Mechanical equipment cold alignment checks and rotation verification.

x.) Witness verification that piping loads on machinery equipment meet specifications.

xi.) Pump installation check out

xii.) Coating and lining tests

xiii.) Surface preparation, paint application and thickness verification.

(g) Final checking of installed facilities, completing check out forms, and signing on behalf of the Contractor documents attesting completion of the work, as called for in the Contractor documents.

(h) Monitoring or inspecting the work of Sub-contractors - This requires pre-award and pre-field start meetings for major subcontracts with

Contractor's / Sub-Contractor / Purchaser participation to establish quality (QA/QC) requirements and how they will be met. Typical areas/disciplines may include, but not be limited to the following:

(i) Foundations
(ii) Field fabricated vessel
(iii) Tanks
(iv) Piping
(v) Electrical
(vi) Instrumentation
(vii) Insulation
(viii) Painting
(ix) Buildings

(i) Execute Contractor's standard quality tracking program.

(j) Perform final check of installed facilities with Purchaser's representatives to verify completeness and accuracy in accordance with P and ID's / Engineering Flow Diagrams and other scope documents as may be required.

(k) "Source" inspect/monitor any field award shop fabrication orders as specified.

(l) See that proper protective procedures are employed and maintained for early installed equipment and equipment stored in offsite staging areas.

2.6.6 Non-conformances of on-site Fabrication and Installation
This section shall control on-site fabrication and installation items, which do not conform to the engineering design or for which the engineering design is incorrect.

2.6.7 Calibration of test equipment
Calibration of tools, gauges, instruments and other measuring and testing devices shall be included.

2.6.8 QA personnel qualification and certification
The qualification required of QA/QC personnel shall be outlined.

2.6.9 Quality assurance/Quality Control Records
The system, which shall ensure that all quality assurance records are maintained for ready reference and shall also provide for the accumulation, evaluation, retention and distribution of QA/QC records.

2.6.10 Interface with Statutory Authorities
Participation of statutory authorities, which require testing, witnessing and inspection, shall be provided.

2.6.11 Audits
Requirements for audits to verify implementation of the QA/QC program on a regular basis shall be included.

2.6.12 Mechanical Completion Acceptance
Contractor shall perform final inspection of the Work in accordance with the Contract documents.

2.6.13 Periodic reporting of QA/QC activities (once a month or earlier) as required shall be submitted.

2.7 Inspection at Works

Purchaser shall witness all the tests including performance tests of all the items like fans, pumps and all other equipment in contractor's/sub-contractor's works before dispatch.

INSPECTION REQUEST FORM

From :

To :

Attn :

Dear Sirs,

Items detailed below are ready for inspection. Please arrange inspection and confirm the date of inspection.

1.	Purchaser	:	
2.	Project	:	
3.	Purchaser's order reference	:	
4.	Consultant's reference	:	
5.	Sub-order reference	:	
6.	Sub-contractor's name and full address	:	
7.	Place of Inspection (full address)	:	
8.	Contact person, telephone no. and fax no.	:	
9.	Description of item and quantity	:	
10.	Nature of inspection required	:	
11.	Proposed date(s)	:	
12.	Weekly holiday	:	

We confirm that the items have been fully inspected/tested by us at all stages, of inspection as per quality plan, and all material test certificates, QC records, test Reports, calibration records of measuring/testing instruments with tractability to national level are available with us.

Thanking you and awaiting your confirmation.

Yours faithfully,

Cc: Sub-contractor

capacity	+ 3% of design head (for 152.4 meter and above)

Results must show no minus tolerance with regard to flow and head.
No minus tolerance on efficiency or positive tolerance on power input at motor terminals shall be allowed.

5) It is preferred to carry out performance, NPSH(R) & Dry Running tests of the boiler feed pump at design speed. However, in case of any constraint of manufacturer to carry out the above tests at design speed, the testing of pump at reduced speed as per HIS guidelines may be proposed to Owner for review and approval.

15.0. LOW PRESSURE PIPING

Sl.No.	Tests/Check Items / Components	Material Test	DPT/MPI	Ultrasonic Test	WPS/ WQS/PQR	Balancing	Hydraulic / Water Fill Test	Pneumatic Test	Assembly Fit up	Dimensions	Functional/operation al Test	Performance Test	Other tests	All Tests as per Relevant Std	Adhesion / Spark	Remarks
1)	Pipes & Fittings and Metered Bends	Y[a]	Y[b]		Y		Y									
2)	Diaphragm Valves	Y[a]					Y[5]			Y				Y[6]		
3)	Butterfly Valves (Low Pressure)															
a)	Casted Butterfly Valves															
(i)	Body (Cast)	Y[a]	Y[b]				Y		Y	Y	Y		Y[7]			
(ii)	Disc (Cast)	Y[a]	Y[b]													
(iii)	Shaft	Y[a]	Y	Y[c]												
b)	Fabricated Butterfly Valves															Ref. Note14
4)	Gate / Globe / Swing Check Valves	Y[a]	Y[b]	Y[c]			Y[5]	Y	Y				Y[8]			
5)	Dual Plate Check Valves	Y[a]	Y[b]	Y[c]			Y	Y	Y				Y[4]			
6)	Rolled & Welded Pipes	Y[a]	Y[3]		Y		Y[1]			Y						
7)	Coating & Wrapping of Pipes	Y[2]											Y[2]			
8)	Tanks & Vessels	Y[a]	Y[b]		Y		Y									
9)	Strainers	Y[a]	Y[b]				Y						Y[11]			
10)	Rubber Expansion Joints	Y[a]					Y[12]		Y				Y[13]			
11)	Rubber Lining of Pipes	Y[a]	Y[b]		Y		Y			Y				Y[9]	Y	

Sl.No.	Tests/Check Items / Components	Material Test	DPT/MPI	Ultrasonic Test	WPS/ WQS/PQR	Balancing	Hydraulic / Water Fill Test	Pneumatic Test	Assembly Fit up	Dimensions	Functional/operational Test	Performance Test	Other tests	All Tests as per Relevant Std	Adhesion / Spark	Remarks
12)	Hangers & Supports	Y[a]						Y								
13)	Fastners	Y[a]		Y[b]				Y								
14)	Site Welding		Y[1]		Y		Y									

Notes:

1. Weld Joints not subjected to hydralic 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

3. DPT on route run and after back gouging and on finish welds.

4. Dry Cycle Test (Spring Cycle Test) for one lakh Cycles shall be carried out as a type test.

5. Seat Leakage Test for Actuator Operated Valves, shall be done with by closing the valves with actuator.

6. Tests on rubber parts per batch of rubber mix such as hardness, adhesion, spark test, bleed test and flex test on diaphragm, type test for diaphragm for 50,000 cycles.

7. Hydraulic Test of Body, Seat and disc-strength shall be carried out in accordance with latest edition of AWWA-C-504 in presence of Owner representatives. Actuator operated valves shall be checked for Seat Leakage by closing the valves with actuator. Seat Leakage Test shall be carried out in both directions.

8. Blue matching, wear travel for gates, valves, pneumatic seat leakage, 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 9.

9. Hardness, Bleeding Test and Ozone resistance test shall be done on rubber material

10. 2% of welds shall be subjected to DPT.

11. Pressure drop across the strainer for each type and size as a special test shall be carried out

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. For fabricated butterfly valves: UT as per ASTM A-435 on plates material for body and disc. 100% RT as per ASTM, Section-VIII, Division-I, on butt joins of body and disc and post weld heat treatment as per ASME, Section-VIII, Division- I on butt joints of body and disc of thickness above 30mm shall be carried out in addition to other tests indicated for cast butter fly valves.

a) One per heat/heat treatment batch/lot.
b) On machined surfaces only for castings and on finished butt welds.
For shaft/spindles > or = 50

16.0 CONDENSER ON LOAD TUBE CLEANING SYSTEM/DEBRIS FILTER FOR MAIN TURBINE CONDENSER AND DRIVE TURBINE CONDENSER (IF OFFERED)

16.1 General Requirements

Refer QA & I portion of General Technical conditions of technical specification.

16.1.1 Ball Recirculation Pump

(a) All rotating parts shall be dynamically balanced.
(b) Pump casing shall be subjected to hydraulic test at 1.5 times the shut off head or twice the maximum working pressure whichever is higher.
(c) Complete pump assembly shall be subjected to shop performance test at supplier's works.

16.1.2 Ball Sorter / Fabricated Body (housing)

(a) In the case of fabricated design, all butt welds shall be subjected to 10% radiographic/ultrasonic examination. All welds shall be examined by 10% magnetic particle testing method to ensure freedom from surface and sub-surface defects.
(b) Body shall be subjected to hydraulic pressure test at 1.5 times the design pressure.
(c) Performance test shall be carried out on ball sorter assembly.

16.1.3 Strainer

(a) Strainer mesh shall be checked for chemical composition and mesh size.
(b) Strainer body shall be subjected to hydraulic pressure test at 1.5 times the design pressure.
(c) Strainer assembly shall be checked for its function.

16.1.4 The complete system and the individual equipment shall be subjected to performance testing at Site to demonstrate successful operation and performance to meet the design conditions. The tests shall also include hydraulic test, function test, check for interlocks and sequential operation. Site test shall also include test to establish pressure drop across the strainer section, proper functioning of DELTA-P system.

16.1.5 Piping and Fittings

Piping and fabricated fittings shall be subjected to following NDT.

Section M15 : WATER TREATMENT & WATER SYSTEM

Tests/Check Items / Components	Material Test	WPS/PQR/Welder Qualification	DPT/MPI	Assembly Fit up	Dimension	RT	Hydraulic / Water Fill	Performance Test	Test as per relevant Std/ Appd.	Other Tests
1. Horizontal Centrifugal Pumps				Y	Y			Y[1]	Y	
1.1. Casing	Y[a]		Y[b]				Y			
1.2. Impeller	Y[a]		Y[b]							Y[d]
1.3. Shaft	Y[a]		Y						Y[c]	
2. Vertical Pumps				Y	Y			Y[1]	Y	
2.1. Casing	Y[a]		Y[b]				Y			
2.2. Impeller	Y[a]		Y[b]							Y[d]
2.3. Shaft	Y[a]		Y						Y[c]	
2.4. Fabricated Parts	Y[a]	Y	Y[b]			Y[2]	Y			
3. Dosing/ Metering Pumps	Y[a]						Y	Y[1]	Y	
4. Gate/ Globe/ Check Valves	Y[a]		Y[b]		Y		Y	Y	Y	Y[6]
5. Dual Plate Check Valves	Y[a]		Y[b]		Y		Y	Y	Y	Y[12]
6 Diaphragm Valves	Y[a]				Y		Y[3]		Y	Y[4]
6. Butterfly Valves (Low Pr.)				Y	Y		Y[3]	Y		Y[5]
7.1Body (Cast)	Y[a]		Y[b]							
7.2Disc (Cast)	Y[a]		Y[b]							
7.3 Shaft	Y[a]		Y[b]							Y[c]
8. Plug/ Ball Valves (Low Pr.)	Y[a]		Y[b]	Y	Y		Y	Y	Y	
9. Blowers	Y[a]		Y[b]	Y	Y		Y	Y	Y	Y[dc]
10. Atmospheric Storage Tanks/ Pressure Vessels	Y[a]	Y	Y[b]	Y	Y	Y[8]	Y		Y[c]	Y[7]
11. Rubber lining	Y[a]				Y				Y	Y[9]
12. Reactor Clarifier	Y[a]	Y	Y[b]	Y	Y				Y	Y[10]
13. Clariflocculator/ Plate or Tube Settler	Y[a]			Y	Y				Y	
14. Hoists & Cranes	Y[a]	Y	Y[b]	Y	Y	Y[8]		Y	Y	
15. Chlorine	Y[a]	Y	Y[b]	Y	Y	Y[8]	Y			

Tonner										
16. Chlorine Evaporator	Y^a	Y	Y	Y	Y	Y	Y			
17. Chlorinator & injector	Y^a			Y	Y		Y	Y		
18. Agitators /Flash Mixer/ Flocculator	Y^a	Y	Y^b	Y	Y			Y		Y^{10}
19. Pipes	Y^a	Y		Y	Y		Y		Y	
20. Ventilation/Exhaust Fan	Y^a		Y^b	Y	Y			Y^{11}	Y	Y^{dc}
21. Resins / Activated Carbon Filter	Y^a	Y	Y^b	Y	Y				Y	Y^{10}
22.BUTTERFLY VALVES (HP)	Y^a			Y	Y		Y	Y		
23.BALL VALVES (HP)	Y^a			Y	Y		Y	Y		

LEGEND:	
Y	Applicable
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 20 mm or above.
Y^d	Dynamic Balancing per ISO: 1940, Grade 6.3 minimum.
Y^1	As per HIS, USA
Y^2	10% RT to be conducted on butt welds for Thk >10 mm.
Y^3	Seat Leakage Test for actuator operated valves shall be done by closing the valve with job actuator.
Y^4	Tests on Rubber Diaphragms per batch of Rubber mix such as Tensile, Elongation, Hardness, Thickness, Bleed Resistance, Flex Test for 1500 cycles etc. shall be conducted. In addition, Type Test for 50,000 cycles for each type of diaphragm shall also be conducted, if not carried out earlier
Y^5	Seat Leakage Test is required to be done in both directions. Disc strength test as per relevant code shall be carried out.
Y^6	Blue Matching, Wear Travel for Gate Valves, reduced pressure test for check valves shall be conducted 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 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 correspondingcode fir 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}	Blue Matching, reduced pressure test for check valves shall be conducted per relevant standards. 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

NOTE: 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.

ANNEXURE II: SUB VENDORS LIST

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
1.	PRESSURE VESSELS	GLOBAL STRUCTURES & COMPOSITE	-	

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		LTD		
		JASMINO POLYMERTECH	TALOJA	
		SYSCON ENGINEERS	AMBERNATH	
		S.V. FABRICATORS	NAVI MUMBAI	
		SPARK FABRICATORS / STEELCON	-	
		ANUP ENGINEERING	AHMEDABAD	
		MURTHAL TANKS & VESSELS	SONEPAT	
		TITAN ENGG.	DURGAPUR	
		RISHI INDUSTRIES	BAHALGARH	
		UNIVERSAL HEAT EXCHANGERS	-	
		ATS CHEM	SALEM/HOSUR	
		CHEM PROCESS SYSTEM	SANAND	
		PROGEN	CHENNAI	
		CRYSTAL ENGINEERING	HOSUR	
		ISHAN EQUIPMENTS	VADODARA	
2.	**ATMOSPHERIC/ STORAGE TANKS**	GLOBAL STRUCTURES & COMPOSITE LTD	-	
		JASMINO POLYMERTECH	TALOJA	
		SYSCON ENGINEERS	AMBERNATH	
		S.V. FABRICATORS	NAVI MUMBAI	
		SPARK FABRICATORS / STEELCON	-	
		ANUP ENGINEERING	AHMEDABAD	
		MURTHAL TANKS & VESSELS	SONEPAT	
		TITAN ENGG.	DURGAPUR	
		RISHI INDUSTRIES	BAHALGARH	
		UNIVERSAL HEAT EXCHANGERS	-	
		ATS CHEM	SALEM/HOSUR	
		CHEM PROCESS SYSTEM	SANAND	
		PROGEN	CHENNAI	
		CRYSTAL ENGINEERING	HOSUR	
		ISHAN EQUIPMENTS	VADODARA	
3.	**RUBBER LINING (AT SHOP)**	TEMSEC	KOLKATA	
		RISHI INDUSTRIES	SONEPAT	
		CORI ENGINEERS	CHENNAI	
		POLY RUBBER	MUMBAI	
		INDUSTRIAL LINING	VADODARA	
		ARUL RUBBERS	CHENNAI	
		JASMINO POLYMERTECH	TALOJA	
		WESTERN RUBBER	NAVI MUMBAI	
		ELASTOMER LINNING	AMBERNATH	
		EMKAY RUBBER	MUMBAI	
4.	**AIR BLOWERS (TWIN LOBE TYPE)**	SWAN PNEUMATIC	NOIDA	
		EVEREST TRANSMISSION	NEW DELHI	
		KAY INTERNATIONAL	NEW DELHI / SONEPAT	
		EVEREST BLOWER	BAHADURGARH	
		KULKARNI POWER TOOLS	KOLHAPUR/ PUNE	

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
5.	METERING PUMPS	VK PUMPS	NASIK	
		MILTON ROY INDIA	CHENNAI	
		SWELLORE	AHMEDABAD	
		POSITIVE METERING PUMPS	NASIK	
		METACHEM	MUMBAI	
6.	AGITATOR	REMI PEOCESS PLANT & M/C	MUMBAI	
		FIBRE & FIBRE	MUMBAI / SILVASA	
		CEECONS	CHENNAI	
		STANDARD ENGINEERS	MUMBAI	
7.	HORIZONTAL CENTRIFUGAL PUMPS	BEST AND CROMPTON ENGG LTD.	CHENNAI	
		BHARAT PUMPS & COMPRESSORS LTD	ALLAHABAD	
		FLOWMORE LTD.	GURGAON	
		FLOWSERVE INDIA CONTROLS PVT. LTD.	COIMBATORE	
		JYOTI LTD.	VADODARA	
		KIRLOSKAR BROTHERS LTD	PUNE	
		WILO MATHER & PLATT PUMPS PVT. LTD.	PUNE	
		V-FLO PUMPS & SYSTEMS CO. LTD.,	BEIJING-CHINA	
		WPIL LIMITED	KOLKATA	
8.	VERTICAL CENTRIFUGAL PUMPS	BHARAT PUMPS & COMPRESSORS LTD	ALLAHABAD	
		FLOWMORE LTD.	GURGAON	
		FLOWSERVE INDIA CONTROLS PVT. LTD.	COIMBATORE	
		JYOTI LTD.	VADODARA	
		WILO MATHER & PLATT PUMPS PVT. LTD.	PUNE	
		SULZER PUMPS INDIA LTD.	THANE	
		WPIL LIMITED	KOLKATA	
9.	SCREW PUMP	UT PUMP		
		ROTO PUMPS		
		TUSHACO		
10.	HORIZONTAL CENTRIFUGAL PUMPS (RUBBER LINED)	KISHORE PUMPS	PUNE	
		SU MOTORS	MUMBAI	
11.	NON METALLIC (PP/FRP) HORIZONTAL CENTRIFUGAL PUMPS	ENGINEERS COMBINE	THANE	
		ANTICORROSIVE	VALSAD	
		LEAK PROOF PUMPS PVT. LTD. (RAJEDIA)	-	
12.	MISC. PUMP VERTICAL TURBINE TYPE	KBL	PUNE	
		M&P	PUNE	
		WPIL	GHAZIABAD	
		KISHORE PUMPS	PUNE	
		FLOWMORE	SAHIBABAD	
		CHHABI ELECTRICALS PVT.LTD.	JALGAON	
		CHLORIDE POWER SYSTEMS & SOLUTIONS LIMITED	KOLKATA	
		DUBAS ENGG PVT LTD	BANGALORE	
		HBL POWER SYSTEMS LTD	HYDERABAD	
		JEMA ENERGY	SPAIN	FOR STATIC SCR TYPE

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
				FULL WAVE FULLY CONTROL TYPE
		MASS-TECH CONTROLS PVT.LTD.	MUMBAI	
		STATCON POWER CONTROLS LTD	NOIDA	
13.	UNDER BED NOZZLE	JONSONS SCREEN	AUSTRALIA/ IRELAND	
14.	COATING & WRAPPING MATERIAL TAPE	IWL LTD.	CHENNAI	
		MP TAR PRODUCT	BHILAI	
		PORWAL INDUSTRIES	RAIPUR	
		RUSTECH	KOLKATA	
		STP	JAMSHEDPUR	
15.	HEATER	ESCORTS	FARIDABAD	
		RACOLDS	FARIDABAD	
16.	CLARIFIER/ THICKENER MECHANISM	CLEAR WATER	DELHI	
		TRIVENI	NOIDA	
		PBJ ASSOCIATE	PUNE	
17.	CENTRIFUGE	HUMBOLT	-	
		HILLER	-	
18.	CAST IRON GATE/GLV/NRV/SRV	A.V. VALVES LTD	AGRA	
		ATAM VALVES PVT. LTD.	JALANDHAR	
		FLUIDLINE VALVES COMPANY PVT.LTD.	GHAZIABAD	
		G.M. DALUI AND SONS PVT.LTD.	HOWRAH	
		H.SARKER AND COMPANY	HOWRAH	
		LEADER VALVES LTD.	JALANDHAR	
		VENUS PUMPS AND ENGG. WORKS	KOLKATA	
19.	BALL VALVE (MANUAL /PNEUMATIC/ ELECTRIC) CLASS 150	A.V. VALVES LTD	AGRA	
		AKAY INDUSTRIES PVT.LTD.	DHARWAD	
		BELGAUM AQUA VALVES PVT. LTD.	BELGAUN	
		ASIAN INDUSTRIAL VALVES & INSTRUMENTS.	CHENNAI	
		ATAM VALVES PVT. LTD.	JALANDHAR	
		DEMBLA VALVES LTD.	THANE	
		M/S GM ENGINEERING	RAJKOT	
		HAWA VALVES (INDIA) PVT. LTD.	NAVI MUMBAI	
		INTERVALVE (INDIA) LTD.	PUNE	
		LEADER VALVES LTD.	JALANDHAR	
		MICROFINISH VALVES PVT LTD.	HUBLI	
		NILON VALVES PRIVATE LIMITED	AHMEDABAD	
		SURYA VALVES AND INSTRUMENTS MFG CO.	CHENNAI	
		UNIFLOW	CHENNAI	
		VALTECH INDUSTRIES	MUMBAI	
		VAAS AUTOMATION PVT. LTD.	NEW DELHI	
		WEIR BDK VALVES- A UNIT OF WEIR INDIA PVT. LTD.	NEW DELHI	
		NGEF	BANGALORE	
		KIRLOSKAR ELECTRIC CO LTD.		
		ASEA BROWN BOVERI		

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		MARATHON	KOLKATA	
20.	BUTTER-FLY VALVE	ADVANCE VALVES PVT. LTD.	NOIDA	
		FLUIDLINE VALVES COMPANY PVT.LTD.	GHAZIABAD	
		INSTRUMENTATION LTD.	PALAKKAD	
		INTERVALVE (INDIA) LTD.	PUNE	
		R AND D MULTIPLES (METAL CAST) PVT LTD	MUMBAI	
		SURYA VALVES AND INSTRUMENTS MFG CO.	CHENNAI	
		PENTAIR VALVES AND CONTROLS INDIA PRIVATE LIMITED	NAVI MUMBAI	
		UPADHAYA VALVES MANUFACTURERS PRIVATE LIMITED,	KOLKATA	
		VENUS PUMPS AND ENGG. WORKS	KOLKATA	
		WEIR BDK VALVES- A UNIT OF WEIR INDIA PVT. LTD.	NEW DELHI	
21.	DIAPHRAGM VALVE (MANUAL / PNEUMATIC) CLASS 150	WEIR BDK	HUBLI	
		CRANE FLOW PROCESS	SATARA	
		PROCON	MUMBAI	
		MAJESTIC VALVES (LABLINE)	-	
		HAWA ENGINEERS	AHMEDABAD	
22.	DUAL PLATE CHECK VALVES	ADVANCE VALVES PVT. LTD.	NOIDA	
		FLUIDLINE VALVES COMPANY PVT.LTD.	GHAZIABAD	1. DUAL PLATE CHECK VALVE CI - CLASS 150 & UP TO 600NB, 2. DUAL PLATE CHECK VALVE CCS - CLASS 150 & UP TO 500NB
		R AND D MULTIPLES (METAL CAST) PVT LTD	MUMBAI	
		VENUS PUMPS AND ENGG. WORKS	KOLKATA	CI, CCS & STAINLESS STEEL SPRING ASSISTED DUAL PLATE CHECK VALVES UPTO 700 NB AND 150 CLASS RATING.
23.	Y-TYPE STRAINER / STRAINER (WATER SERVICE)	OTOKLIN GLOBAL BUSINESS LIMITED	MUMBAI	
		GRAND PRIX	NEW DELHI	
		JAYPEE	NEW DELHI	
		GREAVES COTTON	MUMBAI	
		MULTITEX FILTRATION ENGINEERS LIMITED,	NEW DELHI / NOIDA	
		FILTERATION ENGINEERS (I) PVT. LTD	MUMBAI	
		FLUIDNYE	-	
		SUNGOV ENGINEERING PVT. LTD.	DELHI	
		GRAND PRIX	FARIDABAD	
		JAYPEE INDUSTRIES PVT. LTD.	DELHI	
		BHATIA ENGINEERING CO.	DELHI	
24.	RUBBER FLAP TYPE CHECK VALVES	ASHVIK VALVES	-	
		FLOW WAY VALVES	-	
		BDK	-	
		MAJESTIC VALVES (LABLINE INST)	-	
		ADVANCE VALVES	-	
25.	SOLENOID VALVES	ROTEX	-	

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		AVCON	-	
26.	CHAIN PULLEY BLOCK	ARMSEL MHE PVT. LTD	BANGALORE	
		CENTURY CRANE ENGINEERS PVT. LTD.	FARIDABAD	
		HERCULES HOISTS LTD.	RAIGAD	
		LIFTING EQUIPMENTS AND ACCESSORIES	DELHI	
		TUOBRO FURGUSON (INDIA) PVT LTD	KOLKATA	UPTO 10 TONNE.
		TRACTEL TIRFOR INDIA PVT. LTD.	FARIDABAD	
		TECHNO INDUSTRIES	AHMEDABAD	
		ARMSEL MHE PVT. LTD	BANGALORE	
		ALPHA SERVICES	BHIWADI	
		CONSOLIDATED HOISTS PVT LTD	PUNE	UPTO 20 TONNES
		CENTURY CRANE ENGINEERS PVT. LTD.	FARIDABAD	
		EDDY CRANES PVT. LTD.	MUMBAI	CAPACITY UPTO 10 TONS. BOIS BHEL APP.SUB-VENDORS.
		GRIP ENGINEERS PVT. LTD.,	FARIDABAD,	
		GLOBAL TECHNOLOGIES	HYDERABAD	
		HERCULES HOISTS LTD.	RAIGAD	
		LIFTING EQUIPMENTS AND ACCESSORIES	DELHI	
		MANGLA HOISTS PVT LTD	NEW DELHI	
		MEEKA MACHINERY PVT. LTD.	AHMEDABAD	
		REVA INDUSTRIES LTD.	FARIDABAD	UPTO 25.0 T CAPACITY.
		ROCKWELL HOISTO CRANES PVT. LTD.	BAHADURGARH	
		SAFEX ENERGY PVT. LTD.	AHMEDABAD	
		TUOBRO FURGUSON (INDIA) PVT LTD	KOLKATA	UPTO 15 TONNES.
		TECHNO INDUSTRIES	AHMEDABAD	
27.	ELECTRIC HOIST	ARMSEL MHE PVT. LTD	BANGALORE	
		ALPHA SERVICES	BHIWADI	
		CONSOLIDATED HOISTS PVT LTD	PUNE	UPTO 20 TONNES
		CENTURY CRANE ENGINEERS PVT. LTD.	FARIDABAD	
		EDDY CRANES PVT. LTD.	MUMBAI	CAPACITY UPTO 10 TONS. BOIS BHEL APP.SUB-VENDORS.
		GRIP ENGINEERS PVT. LTD.,	FARIDABAD,	
		GLOBAL TECHNOLOGIES	HYDERABAD	
		HERCULES HOISTS LTD.	RAIGAD	
		LIFTING EQUIPMENTS AND ACCESSORIES	DELHI	
		MANGLA HOISTS PVT LTD	NEW DELHI	
		MEEKA MACHINERY PVT. LTD.	AHMEDABAD	
		REVA INDUSTRIES LTD.	FARIDABAD	UPTO 25.0 T CAPACITY.
		ROCKWELL HOISTO CRANES PVT. LTD.	BAHADURGARH	
		SAFEX ENERGY PVT. LTD.	AHMEDABAD	
		TUOBRO FURGUSON (INDIA) PVT LTD	KOLKATA	UPTO 15 TONNES.

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		TECHNO INDUSTRIES	AHMEDABAD	
28.	CONTROL VALVE	SPX CORPORATION, USA	AHMEDABAD	
		CONTROL COMPONENT INC.	CALIFORNIA	
		DRESSER VALVE INDIA PVT. LTD	COIMBATORE	
		DAUME REGELARMATUREN GMBH,	GERMANY	
		EMERSON PROCESS MANAGEMENT CHENNAI LIMITED	CHENNAI	
		WEIR VALVES & CONTROLS UK LTD.	U.K	
		HOLTER REGELARMATUREN GMBH & CO.KG	GERMANY	
		INSTRUMENTATION LTD.	KERALA	
		KOSO INDIA PRIVATE LIMITED,	NASHIK	
		LESLIE CONTROLS, INC	USA	
		MIL CONTROLS LTD.	KERALA	
		METSO SINGAPORE PTE. LTD.,	SINGAPORE	
		PARCOL S.P.A	ITALY	
		R.K.CONTROL INSTRUMENTS PVT. LTD.	THANE	
		RINGO VALVULAS S.L,	SPAIN	
		SHENJIANG VALVE CO. LTD.	CHINA	
		VALVITALIA S.P.A. ,	ITALY	
		WALDEMAR PRUSS ARMATURENFABRIK GMBH	GERMANY	
		ASHCROFT INDIA PVT LTD.	GUJARAT	
		BUDENBERG GUAGE CO.LTD.	UK	
		FORBES MARSHALL (HYD) LTD.	HYDERABAD	
		GOA INSTRUMENTS INDUSTRIES PVT.LTD.,	GOA	
		GOA THERMOSTATIC INSTRUMENTS PVT.LTD.		
		GAUGE BOURDON INDIA PVT. LTD.	MUMBAI	
		H.GURU INDUSTRIES	KOLKATA	
		H.GURU INSTRUMENTS (SOUTH INDIA) P. LTD	BANGALORE	
		BAUMER TECHNOLOGIES INDIA PVT. LTD.	MUMBAI	
		FLOW STAR ENGINEERING PVT. LTD.,	FARIDABAD	
		FLOWTECH INSTRUMENTS SERVICRS	VADODARA	
		INSTRUMENTATION ENGINEERS PVT LTD	TELANGANA	
		SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	NAVI MUMBAI	
		ABB	-	
		HONEYWELL	-	
		V AUTOMAT	-	
		YOKOGAWA	-	
		SIEMENS	-	
		FORBES MARSHALL	-	
		YOKOGAWA	-	
		HONEYWELL	-	
		ABB	-	

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		HACH	-	
		FORBES MARSHALL	-	
		APC	BANGALORE	
		DELTA	GURGAON	
		EMERSON	MUMBAI	
		DB POWER	PUNE	
		APLAB	MUMBAI	
		COMET	-	
		DOWELL	-	
		CHETNA	-	
29.	MS PLATES	SAIL		
		ESSAR STEEL		
		TISCO		
		RINL		
		JINDAL		
		LLOYD		
		ISPAT		
		INDIAN IRON & STEEL CO. LTD		
30.	CS PIPE (ASTM A 106 GR. B)	INDIAN SEAMLESS METAL TUBES	AHMEDABAD	UPTO 150 NB
		MAHARASHTRA SEAMLESS	RAIGAD	UPTO 350 NB
31.	MS PIPES (IS: 1239 & 3589)	SAIL	ROURKELA	
		JINDAL	GHAZIBAD/HISSAR	
		SURYA ROSHNI	BAHADUR GARH	
		TATA TUBE	JAMSHEDPUR	
		PSL	CHENNAI/VIZAG/KUTCH/DAMAN	
		LALIT PROFILE	THANE	
		SAMSHI PIPES INDUSTRIES	VADODARA	
		MUKUT PIPES	RAJPURA	
		INDUS TUBES	G B NAGAR	
		MANN IND	INDORE	
		SURENDRA ENGG	RAJPURA	
		PRATIBHA PIPES & STRUCTURE PVT LTD	THANE	
		JCO GAS PIPE	CHINDWARA	
		NUKAT TANKS AND VESSELS	TARAPUR	
		DADU PIPES	SIKRANDRABAD	
		GOOD LUCK TUBES	SIKANDRABAD	
		ADVANCE STEEL TUBES	SAHIBABAD	
		BIHAR TUBES	SIKANDRABAD	
		HI TECH PIPES	SIKANDRABAD	
		RATNAMANI	KUTCH/AHMEDABAD/CHHATRAL	
		MAHARASHTRA SEAMLESS	RAIGAD	
		WELSPUN	ANJAR/BHARUCH	

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
32.	SS PIPES / TUBES	APEX TUBES	BEHROR (ALWAR)	
		RATNAMANI	CHATTRAL	
		REMI	TARAPUR	
		PRAKASH STEELAGE	-	
		RADIANT CABLES	HYDERABAD	
		POLYCAB	DAMAN	
		KEI	BHIWADI	
		NICCO	KOLKATA	
		RAVIN CABLES	PUNE	
		INCAB	PUNE	
		HVPL	FARIDABAD	
		TORRENT CABLE	NADIAD	
		HAVELLS	ALWAR	
		PARAMOUNT	KHUSHKHERA	
		SRI RAM CABLES	BHIWADI	
		THERMOCABLES	HYDERABAD	
		TORRENT CABLE	NADIAD	
		UNIVERSAL CABLES	SATNA	
		GEMSCAB	BHIWADI	
		DELTON	FARIDABAD	
33.	SAFETY SHOWER	UNICARE	-	
		MOHAN INDUSTRIES	-	
		SUPER SAFETY SERVICES	-	
34.	FRP TANKS & FITTINGS	GLOBAL COMPOSITE	-	
		EPP	-	
		DEEPA COMPOSITE	-	
		COROSEAL INDUSTRIES	-	
		CHEMICAL PROCESS & EQUIPMENT PVT LTD	-	
		J.R FIBRE INDUSTRIES PVT LTD	-	
		POLYPLAST	-	
35.	EJECTOR	ESSEM TECHNOLOGIES	-	
		RATNA PRASAD	-	
		POSITRONICS	-	
		DELTA CONTROL	-	
		L & T	-	
		GE POWER	-	
		PYROTECH	-	
		C& S	-	
36.	TANK (FRP)	INDUSTRIAL SERVICE	KOLKATA	
		SUNRISE	BARODA	
		GANDHI & ASSOCIATES	AHMEDABAD	
		MODERN EQUIPMENTS	CHENNAI	
		EAGLE PLAST	PUNE	

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		OMEGA PLAST	MUMBAI	
		METACHEM	MUMBAI	
		SWELORE	AHMEDABAD	
		MILTON ROY INDIA	CHENNAI	
37.	SAFETY VALVES/RELIEF VALVES	METACHEM	MUMBAI	
		KEYSTONE	BARODA	
		V K PUMPS	NASIK	
		MILTON ROY	CHENNAI	
38.	DUPLEX STRAINER	JAYPEE INDUSTRIES PVT. LTD.	NEW DELHI	
		MULTITEX FILTRATION ENGINEERS LIMITED,	NEW DELHI	
		OTOKLIN GLOBAL BUSINESS LIMITED	MUMBAI	
		SUNGOV ENGINEERING PVT. LTD.	CHENNAI	
39.	ORIFICE PLATE	MICRO PRECISION	FARIDABAD	
		INSTRUMENTAION LTD	PALGHAT	
		CARLO DYNAMICS	HYDERABAD	
40.	STEEL GATE/GLOBE/NR VALVES	A.V. VALVES LTD	AGRA	
		ATAM VALVES PVT. LTD.	JALANDHAR	(1) CARBON STEEL GATE VALVES & NON RETURN VALVES: 15 NB TO 50 NB (#800) & 65 NB TO 300 NB (#150) (2) CARBON STEEL GLOBE VALVES: 15 NB TO 50 NB (#800) & 65 NB TO 200 NB (#150)
		FLUIDLINE VALVES COMPANY PVT.LTD.	KAUSHAMBI	
		M/S GM ENGINEERING	RAJKOT	
		INTERVALVE (INDIA) LTD.	PUNE	A) STEEL GATE VALVES: UPTO 50NB, #800 AND 65NB TO 150NB, #150 B) STEEL GLOBE VALVES: UPTO 50NB, #800 AND 65NB TO 100NB, #150 C)SUPPLIER NOT REGISTERED FOR NR VALVES
		LEADER VALVES LTD.	JALANDHAR	
		NITON VALVE INDUSTRIES PVT LTD	MUMBAI	
		NSSL LIMITED.	NAGPUR	
		STEEL STRONG VALVES (I) PVT.LTD.,	NAVI MUMBAI	LIMITED TO RANGES & CLASSES AS AVAILABE IN VD FILE.
		VENUS PUMPS AND ENGG. WORKS	KOLKATA	CC/CSS-GATE-BBT-UPTO600NB CL UPTO300,GATE-PSBT UPTO250NB CL 1500,GLV-BBT-UPTO300NB CL UPTO600,SCNRV-BBT-UPTO600NB CL UPTO150,SCNRV-BBT-UPTO300NB CL 300,SCNRV-PSBT-UPTO150NB CL

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
				UPTO900
		VALTECH INDUSTRIES	MUMBAI	
		V.K. VALVES PVT. LTD.,	JALANDHAR	
		WEIR BDK VALVES- A UNIT OF WEIR INDIA PVT. LTD.	NEW DELHI	
41.	SLUICE GATE	H SARKAR	KOLKATA	
		JASH ENGINEERING	-	
		YASHWANT INDUSTRIES	-	
42.	3 WAY VALVE	HI TECH	AHMEDABAD	
		ADVANCE VALVES PVT.LTD	NOIDA	
		BDK	HUBLI	
		FOURESS ENGG.INDIA LTD.	MUMBAI	
		FLUIDLINEVALVES COMPANY PRIVATE LTD.,	MUMBAI	
		INSTRUMENTATION LTD.	PALAKAD	
		KIRLOSKAR BROTHERS LTD.	PUNE	
		VENUS PUMP & ENGG. WORKS	KOLKATA	
		SURYA VALVES AND INSTRUMENTS MANUFACTURING COMPANY	CHENNAI	
		STAFFORD CONTROLS LIMITED	PUNE	
		MICON VALVES (INDIA) PVT.LTD	MUMBAI	
43.	PLUG VALVE(MANUAL)	BDK	HUBLI	
		HAWA ENGINEERS / MARCK & CARE	-	
		MICON VALVES	-	
		MICON VALVES (INDIA) PVT.LTD	MUMBAI	
44.	FITTINGS (CS/SS)	M.S. FITTINGS	KOLKATA	
		METAL LLOYDS	MUMBAI	
		TRUE FORGE	FARIDABAD	
		TUBE PRODUCTS	BARODA	
		NL HAZRA	KOLKATA	
		GUJRAT INFRA PIPES	BARODA	
		EDWARDS	USA	
		PIPEFIT ENGINEERS	BARODA	
		SIDDARTH & GAUTAM	FARIDABAD	
		EBY	MUMBAI	
45.	FLANGES (SS/CS)	PRADEEP METALS LTD	MUMBAI	
		TUBE PRODUCT INCOROPORATION	BARODA	
		MS FITTINGS	KOLKATA	
		HAWA ENGINEERING	-	
		ALIANCE PIPE & PLANGES	KOLKATA	
		JAI AMBE	MUMBAI	
46.	PIPE & FILLTING (PP,HDPE,PVC & CPVC)	GEROGE FISHCHER	DELHI	
		ASTROL PLYTECHINC LTD	AHMEDABAD	
		JAIN IRRIGATION	-	
		ORIPLAST	-	

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
47.	VALVES (GATE/GLOBE/NRV/BALL)- (PP,HDPE,PVC & CPVC)	GEROGE FISHCHER IPING SYSTEMS PVT LTD	DELHI	
		ASTROL PLYTECHINC LTD	AHMEDABAD	
		JAIN IRRIGATION	-	
		ORIPLAST	-	
48.	AIR FILTER REGULATOR	SHAVO NORGEN	-	
		PLACKA INSTRUMENTS	-	
49.	FILTER MEDIA	GLOBAL ABSORBENT	KOLKATA	
		BHARAT MINERALS		
50.	DC LEAD ACID / NI-CD BATTERIES	AMCO SAFT INDIA LTD	BANGALORE	NI-CD BATTERIES ONLY
		EXIDE INDUSTRIES LTD	NEW DELHI	LEAD ACID BATTERIES ONLY.
		HBL POWER SYSTEMS LTD	HYDERABAD	NI/CD AND TUBULAR TYPE FOR LEAD ACID
		HOPPECKE BATTERIEN GMBH & CO.KG,	GERMANY	
51.	DC LEAD ACID BATTERIES	EXIDE INDUSTRIES LTD	NEW DELHI	
		HBL POWER SYSTEMS LTD	HYDERABAD	TUBULAR TYPE
		HOPPECKE BATTERIEN GMBH & CO.KG,	GERMANY	
52.	DC NI CD BATTERIES	AMCO SAFT INDIA LTD	BANGALORE	
		HBL POWER SYSTEMS LTD	HYDERABAD	
		HOPPECKE BATTERIEN GMBH & CO.KG,	GERMANY	
53.	SIGHT FLOW INDICATORS	B.K.EQUIPMENTS PVT.LTD.	CHENNAI	
		BLISS ANAND PVT. LTD.	GURGAON	
		FLOWTECH INSTRUMENTS SERVICRS	VADODARA	
		INSTRUMENTATION ENGINEERS PVT LTD	TELANGANA	
		SIGMA INSTRUMENTS CO.	MUMBAI	
		SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	NAVI MUMBAI	
		TELACE EQUIPMENT PVT.LTD.	CHENNAI	
54.	PAINT	ASIAN PAINTS (I) LTD.		
		BERGER PAINTS INDIA LTD		
		GOODLASS NEROLAC		
		JENSON & NICHOLSON (I) LTD		
		CDC CARBOLINE (I) LTD.		
		SHALIMAR PAINTS LTD.		
		ADDISON PAINTS LTD		
		GRAND POLYCOAT		
		BOMBAY PAINTS		
		HEMPLE PAINTS (SINGAPORE)		
		JOTUN PAINTS		
55.	PNEUMATIC ACTUATOR	PROCON ENGINEERS	-	
		TYCO	-	
		CRANE PROCESS	-	
		BDK	-	
		INTERVALVE	-	

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		BRAY CONTROL	-	
56.	MOTORISED ACTUATOR	ROTARK	-	
		AUMA	-	
		LIMITORK	-	
57.	LT MOTORS	ABB	14, MATHURA ROAD, FARIDABAD, HARYANA-121003	
		BHARAT BIJLEE LTD.	BHARAT BIJLEE LIMITED, 1ST FLOOR, 7-B, RAJINDRA PARK, PUSA ROAD, NEW DELHI - 110 060.	
		CROMPTON GREAVES	3RD FLOOR, EXPRESS BUILDING,9-10, BAHADUR SHAH ZAFAR MARG, NEAR ITO CROSSING,NEW DELHI-110002, INDIA	
		GE-POWER	KAMAK TOWER, 3RD FLOOR, PLOT NO. 12-A, TVK INDUSTRIAL ESTATE, EKKADUTHANGAL, GUINDY, CHENNAI-600032	
		KIRLOSKAR ELECTRIC CO LTD.	P.O. BOX 5555 , MALLESWARAM WEST ,BANGALORE 560055	
		LAXMI HYDRAULICS PVT. LTD	129/130, INDUSTRIAL ESTATE PATIL NAGAR, HOTGI ROAD SOLAPUR-413003, MAHARASHTRA	
		MARATHON	MARATHON ELECTRIC INDIA PRIVATE LTD.SECTOR - 11, MODEL TOWN, FARIDABAD - 121006	
		NGEF	POCKET NO.10, FLAT NO. 37 & 38, EXPANDABLE DDA FLATS, NASIRPUR DWARKA, PHASE-I NEW DELHI-110 045	
		RAJINDRA ELECT INDUSTRIES	14 SHAH IND.ESTATE VEERA DESAI RD,ANDHERI(W) MUMBAI-400053	
		SIEMENS	RC-IN I S NR DEL AREA, JIL BUILDING, TOWER-B, PLOT NO. 78, SECTOR 18, GURGAON-122015, INDIA	
58.	JUNCTION BOXES	Jasper Engineers Pvt. Ltd.	A-23, SECTOR - 8, NOIDA-201301	
		Electro Controls & Devices	F-41, SITE-C, SURAJPUR INDUSTRIAL AREA GREATER NOIDA, UTTAR PRADESH :201308	
		M/s Shrenik & Co.	39A/3, PANCHRATNA INDUSTRIAL ESTATE, SARKHEJ-BAVLA ROAD, CHANGODAR, AHMEDABAD – 382 213	
		M/s PHOENIX MECANO LTD.,	388 BHARE, TALUKA MULSHI, POST GHOTAWADE, PIRANGOOT, INDUSTRIAL AREA, PUNE-412115	
		Adroit Control Engineers Pvt.Ltd.	PLOT-3, KRISHNA INDL. AREA, SECTOR-25 FARIDABAD – 121004	
		M/s PHOENIX MECANO LTD.,	388 BHARE, TALUKA MULSHI, POST GHOTAWADE, PIRANGOOT, INDUSTRIAL AREA, PUNE-412115	
		MIKA ENGINEERS	BRANCH OFFICE : 'D'-101, DHEERAJ HERITAGE	

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
			RESIDENCY II, SHASTRI NAGAR, SANTACRUZ (W), MUMBAI 400 054.	
		M/s PHOENIX MECANO LTD.,	388 BHARE, TALUKA MULSHI, POST GHOTAWADE, PIRANGOOT, INDUSTRIAL AREA, PUNE-412115	
		BAJAJ ELECTRICALS	ENGINEERING & PROJECTS BU (NORTH) 3rd FLOOR, GULMOHARHOUSE, COMMUNITY CENTRE 161/B-4, GAUTAM NAGAR, YUSUF SARAI NEW DELHI – 110049	
		AJMERA INDUSTRIES & ENGG. WORKS	AJMERA INDL. AND ENGG. WORKS. AJMERA HOUSE, A-61 / KHAIRANE MIDC. , TTC INDL. AREA, NAVI MUMBAI – 400705.	
		S.B. ELECTRICAL ENGINEERING CORPORATION	03, SARDAR GRIHA BUILDING, LOHAR CHAWAL, MUMBAI-400002	
59.	**DC BATTERY CHARGER**	AMARA RAJA POWER SYSTEMS LIMITED	TAMIL NADU	
		CHHABI ELECTRICALS PVT.LTD.	MAHARASHTRA	
		CHLORIDE POWER SYSTEMS & SOLUTIONS LIMITED	KOLKATA	
		DUBAS ENGG PVT LTD	BANGALORE	
		EMERSON NETWORK POWER (INDIA) PVT. LTD.	MAHARASHTRA	
		HBL POWER SYSTEMS LTD	HYDERABAD	
		JEMA ENERGY (For Static SCR Type Full Wave fully Control type)	Lasarte-Oria--SPAIN	
		MASS-TECH CONTROLS PVT.LTD.	MUMBAI-MAHARASHTRA	
		STATCON POWER CONTROLS LTD	NOIDA-UTTAR PRADESH	
60.	**DC NI-CD BATTERY**	AMCO SAFT INDIA LTD	BANGALORE-KARNATAKA	
		HBL POWER SYSTEMS LTD	HYDERABAD-TELANGANA	
61.	**DC LEAD ACID BATTERY**	EXIDE INDUSTRIES LTD	NEW DELHI	
		HBL POWER SYSTEMS LTD (FOR TUBULAR TYPE)	HYDERABAD-TELANGANA	
		HOPPECKE BATTERIEN GMBH & CO.KG,	HOPPECKE, GERMANY	
62.	**LUGS**	DOWELLS	47/47A, SATGURU INDUSTRIAL ESTATE. OFF AAREY ROAD, GOREGOAN (EAST). MUMBAI 400 063.	
		UNIVERSAL MACHINES LTD.	4,B.B.D.BAG (EAST) 90,STEPHEN HOUSE,5TH FLR CALCUTTA-700001	
63.	**GLANDS**	ALLIED TRADERS & EXPORTERS	C-124 A, SECTOR-2, NOIDA -201 301, UTTAR PRADESH, INDIA	
		ARUP ENGG & FOUNDARY WORKS	391/119,PRINCE ANWAR SHAH ROAD, CALCUTTA-700068	
		BALIGA LIGHTING EQPT.PVT.LTD.	63A,CP RAMASWAMY ROAD, ALWARPET,P.B.No 6910, CHENNAI-600018	
		COMMET BRASS PRODUCTS	NUTAN CHEMICAL COMPOUND, WALBHAT ROAD,	

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
			GOREGAON, MUMBAI-400063	
		DOWELLS	47/47A, SATGURU INDUSTRIAL ESTATE.OFF AAREY ROAD, GOREGOAN (EAST). MUMBAI 400 063.	
		ELECTROMAC INDUSTRIES	27/28AF NEW EMPIRE IND.ESTT., R.KRISHNA MANDIR RD.JB NGR ,ANDHERI(E),MUMBAI-400059	
		INCAB	HARE STREET,KOLKATA,WEST BENGAL-700001	

1. THE SUB VENDOR LIST ABOVE IS INDICATIVE ONLY AND IS SUBJECT TO BHEL AND CUSTOMER APPROVAL DURING DETAILED ENGINEERING STAGE WITHOUT ANY COMMERCIAL & DELIVERY IMPLICATION TO BHEL.
   BIDDER TO PROPOSE SUB VENDOR WITHIN 4 WEEKS OF PLACEMENT OF LOI. THEREAFTER NO REQUEST FOR ADDITIONAL SUB-VENDOR SHALL BE ENTERTAINED.

2. DEALERS ARE NOT ACCEPTABLE FOR ANY ITEM OF THE PACKAGE. BIDDER SHALL PROCURE ALL ITEMS INCLUDING PLATES, STRUCTURAL, FLANGES; COUNTER FLANGES ETC. FROM APPROVED SUB VENDOR ONLY.

3. THE INSPECTION CATEGORY WILL BE INTIMATED AFTER AWARD OF CONTRACT BY BHEL/CUSTOMER. HOWEVER, THE SAME WILL BE ADHERED BY THE BIDDER WITHOUT ANY COMMERCIAL AND DELIVERY IMPLICATION TO BHEL/ CUSTOMER.

C&I - SUBVENDOR LIST

Package Name	Vendor Name	Vendor Address
CONTROL VALVE	SAMSON CONTROLS PVT. LTD.	Works-1-> Others D 281, MIDC Ranjangaon -Pune-MAHARASHTRA India Phone- 02067246600,8554997963 FAX : Pincode : 412220 Email : sales@samsoncontrols.net
CONTROL VALVE	FORBES MARSHALL ARCA PVT.LTD.	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
CONTROL VALVE	INSTRUMENTATION LTD.	Works-1->D.SASIDHARAN, AGM(Works&PPC) KANJIKODE WEST, -PALAKKAD-KERALA INDIA Phone- 0491-2566536 FAX : 0491-2566135 Pincode : 678623 Email : sasidharan@ilpgt.com;mraj@ilpgt.com;gireesh@ilpgt.com, commercial@ilpgt.com;fa2@ilpgt.com;nazeera@ilpgt.com;pkv@ilpgt.com;remith@ilpgt.com
CONTROL VALVE	Koso India Private Limited,	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;enquiry@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;enquiry@koso.co.in
CONTROL VALVE	KSB MIL CONTROLS LTD.	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
CONTROL VALVE	SUZHOU DELAN ENERGY SCIENCE & TECHNOLOGY CO., LTD.	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 : jeanielei@delan-valve.com
CONTROL VALVE	Valvitalia S.P.A. ,	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
CONTROL VALVE	R.K.CONTROL INSTRUMENTS PVT. LTD.	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
CONTROL VALVE	Mascot Valves Pvt. Ltd.	Works-1->Varun Patel Dir 166-167 ,GIDC Naroda -Ahmedabad-GUJARAT India Phone- 0792282 1619 / 3369 FAX : Pincode : 382330 Email : dom.sales@mascotvalves.com
CONTROL VALVE	BOMAFA SPECIAL VALVE SOLUTIONS PVT LTD	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
CONTROL VALVE	GE OIL & GAS INDIA PRIVATE LIMITED	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
CONTROL VALVE	EMERSON PROCESS MANAGEMENT CHENNAI LIMITED	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
CONTROL VALVE	Severn Glocon India Pvt. Ltd.	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
CONTROL VALVE	WALDEMAR PRUSS ARMATURENFABRIK GMBH	Works-1->Mr. Winfried Dremhel CEO Schulenburgerlandstrasse 261, -Hannover-GERMANY Phone- +49-511279260 FAX : Pincode : 30419 Email : dremhel@pruss.de
PRESSURE SWITCH/DIFF. PRESSURE SWITCH	SWITZER PROCESS INSTRUMENTS PVT. LTD.	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
PRESSURE SWITCH/DIFF. PRESSURE SWITCH	DRESSER INDUSTRIES INC.	
PRESSURE SWITCH/DIFF. PRESSURE SWITCH	GENERAL INSTRUMENTS CONSORTIUM	
PRESSURE SWITCH/DIFF. PRESSURE SWITCH	Barksdale GmbH, Germany	
PRESSURE SWITCH/DIFF. PRESSURE SWITCH	PRECISION MASS PRODUCTS PVT. LTD.	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

PRESSURE SWITCH/DIFF. PRESSURE SWITCH	SOR INC.	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
PRESSURE SWITCH/DIFF. PRESSURE SWITCH	INDFOS INDUSTRIES LIMITED	
PRESSURE SWITCH/DIFF. PRESSURE SWITCH	INDFOS (INDIA) LIMITED	
PRESSURE SWITCH/DIFF. PRESSURE SWITCH	Kaustubha Udyog,	
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	BOSE PANDA INSTRUMENTS PVT.LTD.	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
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	A.N. INSTRUMENTS PVT. LTD.	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
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	H.GURU INDUSTRIES	Works-1->NA NA -- Phone- FAX : Pincode : Email :
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	PRECISION MASS PRODUCTS PVT. LTD.	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
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	Baumer Technologies India Pvt. Ltd.	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
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	H.GURU INSTRUMENTS (SOUTH INDIA) P. LTD	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
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	FORBES MARSHALL (HYD) LTD.	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
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	GAUGE BOURDON INDIA PVT. LTD.	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
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	Nesstech Instruments Private Limited	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
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	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
TEMPERATURE GAUGE	FORBES MARSHALL (HYD) LTD.	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
TEMPERATURE GAUGE	GOA INSTRUMENTS INDUSTRIES PVT.LTD.,	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

TEMPERATURE GAUGE	H.GURU INSTRUMENTS (SOUTH INDIA) P. LTD	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
TEMPERATURE GAUGE	GAUGE BOURDON INDIA PVT. LTD.	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
TEMPERATURE GAUGE	H.GURU INDUSTRIES	Works-1->NA NA -- Phone- FAX : Pincode : Email :
TEMPERATURE GAUGE	GOA THERMOSTATIC INSTRUMENTS PVT.LTD.	Works-1->Mrs Saanvi Naik BICHOLIM, -BICHOLIM-GOA INDIA Phone- 9595855152 FAX : Pincode : 403 529 Email : saanvi.naik@thermostatic.in
TEMPERATURE GAUGE	A.N. INSTRUMENTS PVT. LTD.	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
TEMPERATURE GAUGE	Baumer Technologies India Pvt. Ltd.	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
TEMPERATURE GAUGE	PRECISION MASS PRODUCTS PVT. LTD.	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
LEVEL GAUGE	TOSHNIWAL BROTHERS PVT.LTD.	
TEMPERATURE GAUGE	GOA THERMOSTATIC INSTRUMENTS PVT.LTD.	Works-1->Mrs Saanvi Naik BICHOLIM, -BICHOLIM-GOA INDIA Phone- 9595855152 FAX : Pincode : 403 529 Email : saanvi.naik@thermostatic.in
TEMPERATURE GAUGE	A.N. INSTRUMENTS PVT. LTD.	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
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TEMPERATURE GAUGE	PRECISION MASS PRODUCTS PVT. LTD.	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
LEVEL GAUGE	TOSHNIWAL BROTHERS PVT.LTD.	
LEVEL GAUGE	SIGMA INSTRUMENTS CO.	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
LEVEL GAUGE	BLISS ANAND PVT. LTD.	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
FLOW ELEMENT	MICRO PRECISION PRODUCTS PVT. LTD.	
FLOW ELEMENT	TM TECNOMATIC SPA	Works-1->Mrs. Enrica Bazzocchi VIA DELLE INDUSTRIE, 36, -CREMONA- Italy Phone-39037221574 FAX : 39037228318 Pincode : 26100 Email : sales@tmtecnomatic.com
FLOW ELEMENT	STAR-MECH CONTROLS (I) PVT.LTD.	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
FLOW ELEMENT	INSTRUMENTATION LTD.	
TEMP. ELEMENT	DETRIVE INSTRUMENTATION & ELECTRONICS LTD.	Works-1->Mr. A.D.Solomon J-14, MIDC, TARAPORE, BOISER STN., -THANE-MAHARASHTRA India Phone- FAX : Pincode : Email : trivtech@vsnl.com
TEMP. ELEMENT	Nesstech Instruments Private Limited	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
TEMP. ELEMENT	Thermal Instrument	Works-1->Mr. Raghavendra M. Kulkarni Survey No. 250A/B, Post-Mangaon,Tal.- Kudal,

	India Pvt. Ltd.	Dist.- Sindhudurg, --MAHARASHTRA India Phone- 09322664709 FAX : 022-24455026 Pincode : 416519 Email : ramk@giconindia.com
TEMP. ELEMENT	Baumer Technologies India Pvt. Ltd.	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
TEMP. ELEMENT	GOA INSTRUMENTS INDUSTRIES PVT.LTD.,	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
TEMP. ELEMENT	PYRO ELECTRIC INSTRUMENTS GOA PVT.LTD.	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
TEMP. ELEMENT	GAUGE BOURDON INDIA PVT. LTD.	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
TEMP. ELEMENT	TOSHNIWAL INDUSTRIES PVT. LTD.,	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
TEMP. ELEMENT	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	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
TEMP. ELEMENT	Tempsens Instrument (I) Pvt Ltd	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
TRANSMITTERS	Pune Techtrol Pvt. Ltd.	
TRANSMITTERS	YOKOGAWA INDIA LIMITED,	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
TRANSMITTERS	V. AUTOMAT & INTRUMENTS (P) LTD.	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
TRANSMITTERS	ABB INDIA LIMITED	
TRANSMITTERS	TOSHNIWAL INDUSTRIES PVT. LTD.,	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
TRANSMITTERS	SBEM PVT. LTD.	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
TRANSMITTERS	Endress + Hauser (India) Pvt. Ltd.,	Works-1-> M-171 to 173, MIDC, Waluj, -Aurangabad-MAHARASHTRA India Phone-9881000474, FAX : 0240-2555179, Pincode : 431136, Email : Narendra.Kulkarni@wetzer.endress.com
TRANSMITTERS	Moore Industries International Inc.	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
TRANSMITTERS	PANAM ENGINEERS	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
TRANSMITTERS	SMART INSTRUMENTS LTD, BRAZIL	
TRANSMITTERS	SIEMENS LIMITED	Works-1->Ankit Varshney Kalwa Works, Thane-Belapur Road, Thane, -MUMBAI-MAHARASHTRA INDIA Phone- FAX : Pincode : 400708 Email :
TRANSMITTERS	EMERSON PROCESS MANAGEMENT (INDIA) PVT.LTD.	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
TRANSMITTERS	Honeywell Automation India Limited	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
TRANSMITTERS	NIVO CONTROLS PVT. LTD.	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
TEMPERATURE SWITCH	SOR INC.	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
TEMPERATURE SWITCH	TOSHNIWAL BROTHERS PVT.LTD.	
TEMPERATURE SWITCH	DRESSER INDUSTRIES INC.	
TEMPERATURE SWITCH	INDFOS (INDIA) LIMITED	

TEMPERATURE SWITCH	SWITZER PROCESS INSTRUMENTS PVT. LTD.	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
SIGHT FLOW INDICATORS	V. AUTOMAT & INTRUMENTS (P) LTD.	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
SIGHT FLOW INDICATORS	BLISS ANAND PVT. LTD.	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
SIGHT FLOW INDICATORS	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	
SIGHT FLOW INDICATORS	B.K.EQUIPMENTS PVT.LTD.	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
SIGHT FLOW INDICATORS	SIGMA INSTRUMENTS CO.	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
SIGHT FLOW INDICATORS	INSTRUMENTATION ENGINEERS PVT LTD	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
DIFFERENTIAL PRESSURE SWITCH	SOR INC.	
JUNCTION BOX	K.S.INSTRUMENTS PVT.LTD.	
JUNCTION BOX	SUCHITRA INDUSTRIES	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
JUNCTION BOX	Shrenik & Company,	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
JUNCTION BOX	FLEXPRO ELECTRICALS PVT. LTD.	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
JUNCTION BOX	AJMERA INDUSTRIAL & ENGINEERING WORKS	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
INSTRUMENTS TUBE FITTINGS	VIKAS INDUSTRIAL PRODUCTS	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
INSTRUMENTS TUBE FITTINGS	Fluid Controls Pvt. Ltd.	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
INSTRUMENTS TUBE FITTINGS	PRECISION ENGINEERING INDUSTRIES	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
INSTRUMENTS TUBE FITTINGS	AURA INCORPORATED	
ROTAMETER	INSTRUMENTATION ENGINEERS PVT LTD	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
ROTAMETER	Flow Star Engineering Pvt. Ltd.,	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
ROTAMETER	TANSA EQUIPMENTS PVT. LTD.	Works-1-> Others Mohanjee Sundarjee Road, Raghunath Nagar, Thane -Mumbai-MAHARASHTRA INDIA Phone- FAX : Pincode : 400604 Email :
ROTAMETER	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	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
ROTAMETER	EUREKA INDUSTRIAL EQUIPMENTS PVT.LTD.	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
LEVEL SWITCH-CAPACITANCE TYPE	SIGMA INSTRUMENTS CO.	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
LEVEL SWITCH-CAPACITANCE TYPE	V. AUTOMAT & INTRUMENTS (P) LTD.	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
LEVEL SWITCH-	SCIENTIFIC DEVICES	Works-1->Scientific Center, Others By-Pass Junction,Near Kalsekar College kausa,

CAPACITANCE TYPE	(BOMBAY) PVT LTD,	mumbra,Thane -Mumbai-MAHARASHTRA INDIA Phone- 022-25491409,9892230623 FAX : Pincode : 400612 Email : sdbpl@vsnl.com
LEVEL SWITCH-CAPACITANCE TYPE	LEVCON INSTRUMENTS PVT. LTD.	
LEVEL SWITCH-CAPACITANCE TYPE	Flow Star Engineering Pvt. Ltd.,	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
LEVEL SWITCH-CAPACITANCE TYPE	Pune Techtrol Pvt. Ltd.	
LEVEL SWITCH-CAPACITANCE TYPE	Baumer Technologies India Pvt. Ltd.	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
LEVEL SWITCH-CONDUTIVITY TYPE	Sapcon Instrument Pvt Ltd.	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
LEVEL SWITCH-CONDUTIVITY TYPE	LEVCON INSTRUMENTS PVT. LTD.	Works-1-> 38G, PICNIC GARDEN ROAD, -KOLKATA-WEST BENGAL INDIA Phone- FAX : Pincode : Email :
LEVEL SWITCH-CONDUTIVITY TYPE	BLISS ANAND PVT. LTD.	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
LEVEL SWITCH-CONDUTIVITY TYPE	V. AUTOMAT & INTRUMENTS (P) LTD.	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
LEVEL SWITCH-CONDUTIVITY TYPE	HI-TECH SYSTEMS & SERVICES LTD.	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
LEVEL SWITCH-CONDUTIVITY TYPE	RAMAN INSTRUMENTS PVT.LTD.	Works-1->NA -- Phone- FAX : Pincode : Email :
LEVEL SWITCH-CONDUTIVITY TYPE	SIGMA INSTRUMENTS CO.	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
LEVEL SWITCH-CONDUTIVITY TYPE	SOR INC.	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
LEVEL SWITCH-FLOAT TYPE	Pune Techtrol Pvt. Ltd.	
LEVEL SWITCH-FLOAT TYPE	D.K. INSTRUMENTS PVT.LTD.	
LEVEL SWITCH-FLOAT TYPE	V. AUTOMAT & INTRUMENTS (P) LTD.	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
LEVEL SWITCH-FLOAT TYPE	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	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
LEVEL SWITCH-FLOAT TYPE	LEVCON INSTRUMENTS PVT. LTD.	
LEVEL SWITCH-FLOAT TYPE	GENERAL INSTRUMENTS CONSORTIUM	
LEVEL SWITCH-FLOAT TYPE	SBEM PVT. LTD.	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
LEVEL SWITCH-FLOAT TYPE	Baumer Technologies India Pvt. Ltd.	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
LEVEL SWITCH-FLOAT TYPE	SIGMA INSTRUMENTS CO.	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
LEVEL SWITCH-FLOAT TYPE	SOR INC.	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
INSTRUMENTS PIPE FITTINGS	VIKAS INDUSTRIAL PRODUCTS	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
INSTRUMENTS PIPE FITTINGS	Fluid Controls Pvt. Ltd.	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
INSTRUMENTS PIPE	AURA INCORPORATED	

FITTINGS		
INSTRUMENTS PIPE FITTINGS	PRECISION ENGINEERING INDUSTRIES	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
ULTRASONIC FLOW METERS	Electronet Equipments Pvt Ltd.	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
ULTRASONIC FLOW METERS	Adept Fluidyne Pvt. Ltd.	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
ULTRASONIC FLOW METERS	FLEXIM Flexible Industriemesstechnik GmbH	Works-1-> Others Boxberger Str. 4, -Berlin- GERMANY Phone- 0049 30 93 66 76 60 FAX : Pincode : 12681 Email : info@flexim.de
ULTRASONIC FLOW METERS	Rockwin Flowmeter India Pvt. Ltd.	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
ULTRASONIC FLOW METERS	FLASH FORGE PVT LTD	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 :
ULTRASONIC FLOW METERS	NIVUS GMBH	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
FLOW ELEMENT - ORIFICE	MINCO (INDIA) PRIVATE LIMITED	Works-1-> D/35,TIVIM INDUSTRIAL ESTATE, KARASWADA,MAPUSA, -Goa-Goa India Phone- 9320197825, FAX : 0832-2257262, Pincode : 403526, Email : santoshkumar@general-gauges.com
FLOW ELEMENT - ORIFICE	TANSA EQUIPMENTS PVT. LTD.	Works-1-> Others Mohanjee Sundarjee Road, Raghunath Nagar, Thane -Mumbai-MAHARASHTRA INDIA Phone- FAX : Pincode : 400604 Email :
FLOW ELEMENT - ORIFICE	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	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
FLOW ELEMENT - ORIFICE	CHEMTROLS INDUSTRIES PVT. LTD.	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
FLOW ELEMENT - ORIFICE	Electronet Equipments Pvt Ltd.	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
FLOW ELEMENT - ORIFICE	INSTRUMENTATION LTD.	Works-1->D.SASIDHARAN, AGM(Works&PPC) KANJIKODE WEST, -PALAKKAD-KERALA INDIA Phone- 0491-2566536 FAX : 0491-2566135 Pincode : 678623 Email : sasidharan@ilpgt.com;mraj@ilpgt.com;gireesh@ilpgt.com, commercial@ilpgt.com;fa2@ilpgt.com;nazeera@ilpgt.com;pkv@ilpgt.com;remith@ilpgt.com
FLOW ELEMENT - ORIFICE	HYDROPNEUMATICS PVT. LTD.	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
FLOW ELEMENT - ORIFICE	Flow Star Engineering Pvt. Ltd.,	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
FLOW ELEMENT - ORIFICE	MICRO PRECISION PRODUCTS PVT. LTD.	Works-1->Mr. SANJEEV CHAUHAN ,H.B. No.-40 Others Revenue Estate, Village-Dudhola, Tehsil & Distt.-Palwal -Faridabad-Haryana India Phone-9871620282;9560742713 FAX : Pincode : 121002 Email : Sanjeev.Chauhan@micro-precision.co.in;anil.bhati@wika.com
FLOW ELEMENT - ORIFICE	MINCO (INDIA) FLOW ELEMENTS PVT. LTD.	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
FLOW ELEMENT - ORIFICE	STAR-MECH CONTROLS (I) PVT.LTD.	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
FLOW ELEMENT - ORIFICE	INSTRUMENTATION ENGINEERS PVT LTD	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
FLOW ELEMENT - ORIFICE	DYNAFLUID VALVES AND FLOW CONTROLS (P) LTD.	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
FLOW ELEMENT - NOZZLE	MICRO PRECISION PRODUCTS PVT. LTD.	Works-1->Mr. SANJEEV CHAUHAN ,H.B. No.-40 Others Revenue Estate, Village-Dudhola, Tehsil & Distt.-Palwal -Faridabad-Haryana India Phone-9871620282;9560742713 FAX : Pincode : 121002 Email : Sanjeev.Chauhan@micro-precision.co.in;anil.bhati@wika.com

FLOW ELEMENT - NOZZLE	MINCO (INDIA) FLOW ELEMENTS PVT. LTD.	
FLOW ELEMENT - NOZZLE	HYDROPNEUMATICS PVT. LTD.	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
FLOW ELEMENT - NOZZLE	STAR-MECH CONTROLS (I) PVT.LTD.	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
FLOW ELEMENT - NOZZLE	INSTRUMENTATION LTD.	Works-1->D.SASIDHARAN, AGM(Works&PPC) KANJIKODE WEST, -PALAKKAD-KERALA INDIA Phone- 0491-2566536 FAX : 0491-2566135 Pincode : 678623 Email : sasidharan@ilpgt.com;mraj@ilpgt.com;gireesh@ilpgt.com, commercial@ilpgt.com;fa2@ilpgt.com;nazeera@ilpgt.com;pkv@ilpgt.com;remith@ilpgt.com
FLOW ELEMENT - NOZZLE	DYNAFLUID VALVES AND FLOW CONTROLS (P) LTD.	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
FLOW ELEMENT - NOZZLE	MINCO (INDIA) PRIVATE LIMITED	Works-1-> D/35,TIVIM INDUSTRIAL ESTATE, KARASWADA,MAPUSA, -Goa-Goa India Phone- 9320197825, FAX : 0832-2257262, Pincode : 403526, Email : santoshkumar@general-gauges.com
INSTRUMENT FITTINGS	Perfect Instrumentation Control (India) Pvt. Ltd.	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
INSTRUMENT FITTINGS	Arya Crafts & Engineering Pvt. Ltd.	
INSTRUMENT FITTINGS	HP VALVES & FITTINGS INDIA PVT. LTD.	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
INSTRUMENT FITTINGS	PRECISION ENGINEERING INDUSTRIES	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
INSTRUMENT FITTINGS	AURA INCORPORATED	
INSTRUMENT FITTINGS	Comfit & Valve Pvt. Ltd.	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
INSTRUMENT FITTINGS	FLUIDFIT ENGINEERS PVT. LTD.	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
INSTRUMENT FITTINGS	VIKAS INDUSTRIAL PRODUCTS	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
INSTRUMENT FITTINGS	Fluid Controls Pvt. Ltd.	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
INSTRUMENT FITTINGS	PANAM ENGINEERS	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
ELECTROMAGNETIC FLOW METER	V.A Valves	Works-1->Mr.Vishal Jain Dir Udyog Nagar, Gadaipur, -Jalandhar-PUNJAB INDIA Phone- 01812601741,9872626376 FAX : Pincode : 144004 Email : support@fedrelflowmeters.com
ELECTROMAGNETIC FLOW METER	Adept Fluidyne Pvt. Ltd.	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
ELECTROMAGNETIC FLOW METER	Electronet Equipments Pvt Ltd.	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
ELECTROMAGNETIC FLOW METER	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	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

Note: -

1. The above Sub-vendor list is tentative & reference only. However Sub-vendor list is subject to BHEL/End user approval without any commercial/delivery implication.
2. New Sub-vendor if proposed by vendor during contract stage shall subject to BHEL/ End user approval without any commercial/delivery implication.

ANNEXURE-III

FUNCTIONAL GUARANTEES AND LIQUIDATED DAMAGES

FUNCTIONAL GUARANTEES, LIQUIDATED DAMAGES FOR SHORTFALL IN PERFORMANCE AND GUARANTEE TESTS

1.00 PERFORMANCE GUARANTEES

General Requirements

1.01 The Bidder shall guarantee that the equipment offered shall meet the ratings and performance requirements stipulated for various equipment covered in these specifications.

1.02 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.

1.03 The Bidder shall conduct performance test and demonstrate all the guarantees covered herein under Category I, II & III. The various tests, which are to be carried out during performance guarantee / acceptance test, are listed. The Bidder at site shall conduct the guarantee tests in presence of Purchaser on each unit individually.

1.04 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 contract price.

1.05 The performance tests shall be performed using only the normal number of Employer supplied operating staff. Bidder/vendor or other subcontractor personnel shall be used only 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.

1.06 It shall be responsibility of the Bidder to make the plant ready for the performance guarantee tests. At all times during the performance tests the emission and effluents from the plant shall not exceed the guaranteed emission and effluent limits.

1.07 The term "Performance Guarantees" wherever appears in this Section shall have the same meaning and shall be synonymous to "Functional Guarantees".

1.08 The term "Performance Tests" wherever appears in this Section shall have the same meaning and shall be synonymous to "Guarantee Test(s)"

1.09 The term "TMCR" (Turbine maximum continuous rating) appearing in the Technical Specification shall mean 660 MW electrical power output at generator terminals under 0% cycle make-up and guaranteed optimized condenser pressure unless used in conjunction with a different cycle make up and / or a different condenser pressure.

1.10 The term “BMCR” (Boiler Maximum Continuous Rating) appearing in the Technical Specification shall mean the maximum continuous steam output of steam generator (“As guaranteed”) at super heater outlet at rated parameters.

1.11 Test Instrumentation, Flow Measurement and their Calibration. All instruments required for performance testing shall be of the type and accuracy required by the code prior to the test, the Bidder shall get these instruments calibrated in an independent test Institute approved by the BHEL/customer. All the test instrumentation required for performance tests shall be supplied by the Bidder and shall be retained by him upon satisfactory completion of all such tests at site. All calibration procedures and standards shall be subject to the approval of the BHEL/ customer. The

protecting tubes, pressure connections and other test connections required for conducting guarantee test shall conform to the relevant codes.

1.12 Tools and tackles, thermowell (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 Bidder free of cost.

1.13 The Performance test shall be carried out as per the agreed procedure. The detailed 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 bidder shall submit the test evaluation report of performance test results to customer and BHEL promptly but not later than one month from the date of conductance of performance test. However, preliminary test reports shall be submitted to customer and Bhel after completing each test run.

1.14 The P&G test procedures shall be submitted for equipment/ system & subsystem under Bidder'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.

1.15 The Bidder shall submit for BHEL/customer approval the detailed Performance Test procedure containing the following:

i. Object of the test
ii. Various guaranteed parameters & tests as per contract.
iii. Method of conductance of test and test code.
iv. Duration of test, frequency of readings & number of test runs.
v. Method of calculation.
vi. Correction calculations & curves.
vii. Instrument list consisting of range, accuracy, least count, and location of instruments.
viii. Scheme showing measuring points.
ix. Sample calculation
x. Acceptance criteria.
xi. Any other information required for conducting the test. The Performance test shall be carried out as per the agreed procedure.

1.16 Test Reports

After the conductance of Performance test, the Bidder shall submit the test evaluation report of Performance test results to BHEL/customer promptly but not later than one month from the date of conductance of Performance test. Preliminary test reports shall be submitted to the BHEL/customer after completing each test run. Four (4) hard copies and two (2) soft copies on CD-ROM of each test report of final conducted test on each equipment/plant/system shall be submitted to BHEL/customer for approval.

1.17 The performance guarantee test will be carried out within three months after the successful completion of Initial Operation of facilities or as per the time frame specified for a particular equipment/ plant/ system in the Technical specifications. Delay in conductance of the test beyond this period will not be normally permitted by the BHEL/customer. In the event of BHEL/customer agreeing to conductance of such tests after three months, for reasons not attributable to the BHEL/customer, as assessed by the BHEL/customer, no factor for ageing shall be considered for

computing performance of the equipment. Performance Guarantee Tests on the equipment /systems not covered shall be carried out as per the procedure/test codes specified.

1.18 In case during performance guarantee test(s) it is found that the equipment/system has failed to meet the guarantees, the bidder shall carry out all necessary modifications and/or replacements to make the equipment/system comply with the guaranteed requirements at no extra cost to BHEL / CUSTOMER and re-conduct the performance guarantee test (s) with BHEL / CUSTOMER's consent. In case the specified performance guarantee (s) are still not met by the Bidder even after modification and/or replacement but are achieved with in the acceptable shortfall limit, BHEL / CUSTOMER will accept the equipment/system/plant after levying liquidated damages as mentioned in the specification. However, if, the demonstrated guarantee(s) continue to be beyond the stipulated acceptable short fall limit, even after the modifications/replacements within ninety (90) days or a reasonable period allowed by the BHEL / CUSTOMER, after the tests have been completed, the BHEL / CUSTOMER will have the right to either of the following (at BHEL / CUSTOMER discretion):

a) For Category-I Guarantees

Reject the equipment/system/plant and recover from the bidder the payments already made.

OR

Accept the equipment /system/ plant after levying Liquidated Damages. The liquidated damages shall be prorated for the fractional parts of the deficiencies. These performance guarantees coming under this category shall be called 'Category-I' guarantees.

b) For Category-II Guarantees

Reject the equipment/system/plant and recover from the bidder 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.

c) For Category-III Guarantees

Reject the equipment/system/plant and recover from the bidder 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 BHEL/CUSTOMER. Such damages shall, however be limited to the cost of replacement of the equipments/systems replacement of which shall remove the deficiency so as to achieve the guarantee performance. These parameters / capacities shall be termed as Category-III, guarantees.

2.00 GUARANTEES UNDER CATEGORY I

Auxiliary power consumption -Summation of power consumption of working drives at their rated capacities for Seawge Treatment Plant. Base auxiliary power consumption for Seawge Treatment Plant and penalties shall be as per Section III (GPC format). Bidder to furnish its guaranteed auxiliary power consumption with its technical offer (Not in sealed price).
Bidder to refer guaranteed auxiliary power requirement for Seawge Treatment Plant package drives listed in GPC format. The total power consumption should be within the base power consumption

specified in the format. Auxiliary power consumption shall be used for technical loading as per below mentioned criteria during bid evaluation stage & during demonstration / PG test.

LOADING CRITERIA FOR AUXILIARY POWER CONSUMPTION DURING BID EVALUATION STAGE:

Base auxiliary power consumption figure for the Seawge Treatment Plant (for working drives as specified in GPC format only) has been considered as 46 KW. As long as bidder's quoted guaranteed power consumption (GPC) above remains within Base auxiliary power consumption figure, there will be no technical loading of bid on power consumption for evaluation. However, if bidder's quoted GPC exceeds base auxiliary power consumption figure, there shall be technical loading of bid for evaluation @ 5,84,000/-(Rupees Five lacs and eighty-four thousand per Kilowatt) per KW of additional power over Base auxiliary power consumption figure.

LIQUIDATED DAMAGES CRITERIA FOR AUXILIARY POWER CONSUMPTION DURING DEMONSTRATION / PG TEST

Bidder's guaranteed power consumption as furnished in GPC format shall be demonstrated by the successful bidder during performance testing at works/ site. In case power consumption is noted higher than Base auxiliary power consumption figure / bidder's quoted GPC whichever is higher, during inspection/ PG test, penalty @ 5,84,000/- (Rupees Five lacs and eighty-four thousand per Kilowatt) per additional KW shall be levied on vendor. (+) 1.0% of the guaranteed Auxiliary Power Consumption shall be acceptable shortfall with LD.
If the bidder is not able to demonstrate the guarantees, Customer / BHEL will have the right to Reject the equipment / system / plant and recover the payments already made or accept the equipment / system after levying liquidated damages.

3.00 GUARANTEE UNDER CATEGORY –II

NIL

4.00 GUARANTEE UNDER CATEGORY –III

SEWAGE TREATMENT PLANT
Following parameter / capabilities shall be guaranteed by the Bidder for stp which falls under "GUARANTEE UNDER CATEGORY –III" but not be limited to the following:

a. Sewage Treatment Plant

1. Sewage Treatment Plant shall be guaranteed for an effluent flow capacity of not less than 40 m3/hr.

2. Outlet water from Sewage Treatment Plant shall be guaranteed for the following

pH	:	7.0 – 8.0
BOD	:	Less than or equal to 20 ppm
COD	:	Less than or equal to 100 ppm
Oil & Grease	:	Less than or equal to 5 ppm
Coliform count	:	Less than or equal to 100 MPN / 100 ml
TSS	:	Less than or equal to 20 ppm
NH4-N	:	Less than 5mg/l
N Total	:	Less than 10mg/l
Residual chlorine	:	Not exceeding 0.5 mg/l

b. Noise level of all pumps and blowers at the rated duty point shall be demonstrated at site.

i) Noise: All the STP pumps and blowers covered under this specification shall perform continuously without exceeding the noise level over the entire range of output and operating 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 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.

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 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 days 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 sewage treatment plant.
  - Equipment Cable tray layout of sewage treatment plant.
  - Civil assignment drawings.
  - Piping lay out drawing of sewage treatment plant.

- In addition to above requirement, bidder shall also be furnishing the following documents pertaining to Electric Hoist/ Chain Pulley Block for BHEL/ UPRVUNL approval: -

  - **Chain Pulley Block: -**
  - Manufacturing Quality Plan
  - GA Drawing for Chain Pulley Blocks with detail BOM and Painting details
  - O & M Manual

  - **Electric Hoist:-**
  - Manufacturing Quality Plan
  - GA Drawing for Electric Hoist, DSL arrangement and Painting details
  - Schematic Circuit Diagram
  - Mechanism Sizing Calculation
  - Detailed BOM/BOQ for crane
  - O & M Manual

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-D).

- **e-Learning Package/Module:**
  e-learning packages shall be supplied for the equipment / system for the complete sewage treatment plant along with associated electrical and C&I system. Bidder to refer Section-D 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.

Sl. No.	DOCUMENT / DRAWING NO.	DRAWING / DOCUMENT TITLE	SCHEDULE OF SUBMISSION FROM LOI	SIZE
BASIC ENGINEERING DRAWING/ DOCUMENT				
1	PE-V0-426-673-A001	P&I Diagram for Sewage Treatment Plant	4	A1
2	PE-V0-426-673-A007	Design Calculation of Sewage Sump Pits (As applicable)	14	A4
3	PE-V0-426-673-A002	Layout of Sewage Treatment Plant	4	A1
4	PE-V0-426-673-A020	Operation & Control Philosophy SEWAGE TREATMENT PLANT	6	A4
5	PE-V0-426-673-A008	PROCESS DESIGN AND SIZING CALCULATION INCLUDING PRESSURE DROP CALCULATIONS (STP)	4	A4
6	PE-V0-426-673-A025	Sub Vendor List & inspection criteria for SEWAGE TREATMENT PLANT	4	A4
MANUFACTURING DRAWING/DOCUMENTS				
7	PE-V0-426-673-A016	Data Sheet of Agitator FOR SEWAGE TREATMENT PLANT	10	A4
8	PE-V0-426-673-A005	MECH. GA DRAWINGS OF ALL SEWAGE SUMPS AND TANKS FOR SEWAGE TREATMENT PLANT	10	A1
9	PE-V0-426-673-A006	MECH. GA DRAWINGS OF STP BUIDLING	10	A1
10	PE-V0-426-673-A040	QAP for Control Cable & screened control cables	10	A4
11	PE-V0-426-673-A039	Data sheet Control Cable & screened control cables	10	A4
12	PE-V0-426-673-A015	TECHNICAL DATA SHEET FOR METERING PUMPS FOR SEWAGE TREATMENT PLANT	10	A4
13	PE-V0-426-673-A034	MECH. GA OF LAMELLA TUBE SETTLER CLARIFIER FOR SEWAGE TREATMENT PLANT	10	A1
14	PE-V0-426-673-A013	TECHNICAL DATA SHEET- INSTRUMENTS SEWAGE TREATMENT PLANT	10	A4
15	PE-V0-426-673-A010	DATA SHEET OF VALVES SEWAGE TREATMENT PLANT	10	A4
16	PE-V0-426-673-A027	QAP FOR METERING PUMPS WITH MOTOR FOR SEWAGE TREATMENT PLANT	10	A4
17	PE-V0-426-673-A036	TECHNICAL DATA SHEET OF MOTOR for SEWAGE TREATMENT PLANT	10	A4
18	PE-V0-426-673-A026	QAP FOR SUBMERSIBLE WITH MOTOR SEWAGE TREATMENT PLANT	10	A4
19	PE-V0-426-673-A011	TECHNICAL DATA SHEET OF SUBMERSIBLE PUMPS SEWAGE TREATMENT PLANT	10	A4
20	PE-V0-426-673-A035	QAP FOR VALVES SEWAGE TREATMENT PLANT	10	A4
21	PE-V0-426-673-A012	TECHNICAL DATA SHEET OF SCREW AND HORIZONTAL CENTRIFUGAL PUMPS FORSEWAGE TREATMENT PLANT	10	A4
22	PE-V0-426-673-A028	QAP FOR BLOWERS WITH MOTOR FOR SEWAGE TREATMENT PLANT	10	A4
23	PE-V0-426-673-A033	QAP FOR LAMELLA CLARIFIER TUBE SETTLER FOR SEWAGE TREATMENT PLANT	10	A4
24	PE-V0-426-673-A014	TECHNICAL DATA SHEET OF BLOWERS SEWAGE TREATMENT PLANT	10	A4

25	PE-V0-426-673-A041	GA DRAWING FOR ELECTRIC HOIST, DSL ARRANGEMENT AND PAINTING DETAILS	12	A3
26	PE-V0-426-673-A042	SCHEMATIC CIRCUIT DIAGRAM FOR ELECTRIC HOIST	12	A4
27	PE-V0-426-673-A043	MECHANISM SIZING CALCULATION FOR ELECTRIC HOIST	12	A4
28	PE-V0-426-673-A044	MANUFACTURING QUALITY PLAN FOR ELECTRIC HOIST	12	A4
29	PE-V0-426-673-A045	MANUFACTURING QUALITY PLAN FOR CHAIN PULLY BLOCK	12	A4
30	PE-V0-426-673-A046	GA DRAWING FOR CHAIN PULLEY BLOCK WITH DETAIL BOM WITH PAINTING DETAILS	12	A3

DETAIL ENGINEERING DOCUMENT				
31	PE-V0-426-673-A037	CABLE TRAY/ TRENCH & CONDUIT ROUTING DIAGRAM OF STP	12	A1
32	PE-V0-426-673-A004	YARD PIPING LAYOUT OF STP	16	A1
33	PE-V0-426-673-A003	PIPING LAYOUT OF STP (INSIDE AREA)	10	A1
34	PE-V0-426-673-A017	Instrument Schedule SEWAGE TREATMENT PLANT	12	A4
35	PE-V0-426-673-A021	Valve Schedule SEWAGE TREATMENT PLANT	12	A4
36	PE-V0-426-673-A019	ELECTRICAL LOAD DATA SEWAGE TREATMENT PLANT	8	A4
37	PE-V0-426-673-A022	O & M Manual FOR SEWAGE TREATMENT PLANT	24	A4
38	PE-V0-426-673-A018	Cable Schedule FOR SEWAGE TREATMENT PLANT	16	A4
39	PE-V0-426-673-A023	Painting Schedule FOR SEWAGE TREATMENT PLANT	10	A4
40	PE-V0-426-673-A032	ENGINEERING BOQ FOR SEWAGE TREATMENT PLANT	20	A4
41	PE-V0-426-673-A030	ERECTION PROCEDURE SEWAGE TREATMENT PLANT	16	A4
42	PE-V0-426-673-A047	ERECTION PROCEDURE FOR ELECTRIC HOIST	16	A4
43	PE-V0-426-673-A048	O & M Manual FOR ELECTRIC HOIST AND CHAIN PULLEY BLOCK	24	A4
44	PE-V0-426-673-A031	PG TEST FOR SEWAGE TREATMENT PLANT	20	A4
45	PE-V0-426-673-A038	DCS ENGINEERING DOCUMENTS FOR STP	12	A4

Notes:

1. The above drawing list is tentative and shall be finalized with the successful bidder after placement of order. While some of the drawings indicated above may not be applicable, some additional drawings may also be required based on scope of work.
2. Any other drg/document for completeness of system, needed over and above listed documents shall be submitted by bidder during detailed engineering stage without any commercial and delivery implications.

LIST OF DELIVERABLES (C&I) FOR Sewage Treatment Plant					
S.No.	**DRAWING NO.**	**DRAWING/DOCUMENT TITLE**	**CATEGORY**	**SCH. SUBMISSION WEEK FROM LOI**	**Resubmission after incorporating comments**
46	PE-V0-426-673-I901	CONTROL & OPERATIONAL WRITE-UP FOR THE SYSTEM	A	5	1 week
47	PE-V0-426-673-I902	INSTRUMENT & DRIVE LIST WITH SET POINTS	A	8	1 week
48	PE-V0-426-673-I903	FIELD JB/LIE/LIR,DRIVES TERMINATION DETAILS	A	9	1 week
49	PE-V0-426-673-I904	DATASHEETS FOR INSTRUMENTS, ANALYSERS, JBs, etc. along with CATALOGUES*	A	8	1 week
50	PE-V0-426-673-I905	INPUT / OUTPUT SIGNAL LIST (ANALOG & BINARY)	A	8	1 week
51	PE-V0-426-673-I906	ANNUNCIATION LIST	A	8	1 week
52	PE-V0-426-673-I907	QUALITY PLANS (INSTRUMENTS,LCP etc.)	A	6	1 week
53	PE-V0-426-673-I908	INSTRUMENT INSTALLATION/ HOOK-UP DRAWING	A	6	1 week
54	PE-V0-426-673-I909	CABLE SCHEDULE & CABLE INTERCONNECTION DETAILS IN BHEL FORMAT	A	8	1 week
55	PE-V0-426-673-I910	O & M MANUAL	A	10	1 week
56	PE-V0-426-673-I911	GA & Wiring diagram of Local Control Panels	A	8	1 week
	NOTES:				
1	Any other document for the package decided during detailed engineering shall be provided by Bidder without any commercial/ technical implication.				
2	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 as applicable shall be provided to the successful bidder during detailed engineering.				
3	673- PACKAGE CODE				

ANNEXURE-VI
DOCUMENTS DISTRIBUTION SCHEDULE

S.No.	Description of Document	DESEIN				UPRVUNL			
		HO		SITE		HO		SITE	
		HC	CC	HC	CC	HC	CC	HC	CC
1.	Drawings, Data Sheets, Calculation, all equipment / Instrument Schedule, BOM etc. a) For Approval b) Resubmission c) For Information	6*	1	-	-	2	1	-	-
2.	Final Approved Documents	2	1 + 1 CD	1	1	1	1 + 2 CD	4	1 + 1 CD
3.	Drawings / Documents 'As Built'	2	1 + 1 CD	1	1	2	1 + 2 CD	4	1 + 1 CD
4.	Type Test Reports (Initial)	4*	1 + 1 CD	-	-	2	1 + 2 CD	-	-
5.	Type Test Report (Final)	2	1 + 1 CD	1	1	2	1 + 2 CD	4	1 + 1 CD
6.	Piping / Equipment Analysis (Transient) etc., Model Study Report (Draft) including Input / Output date etc.	4*	1	-	-	2	1 + 1 CD	-	-
7.	Piping / equipment Analysis (Transient) etc. Model Study Report (Final Approval) including Input / Output date	2	1 + 1 CD	-	-	2	1 + 2 CD	2	1 + 1 CD
8.	Erection Manual (Draft)	3*	1CD	-	-	1	1CD	-	-

This pg is part of spec PE-TS-426-673A-A001

93/500

TITLE: TECHNICAL SPECIFICATION FOR SEWAGE TREATMENT PLANT 1X660 MW PANKI THERMAL POWER STATION EXT.

BHEL DOCUMENTS NO.: PE-TS-426-673A-A001
VOLUME II-B
SECTION-C1
REV. NO. 00
DATE:

DRAWING/DOCUMENTS DISTRIBUTION SCHEDULE

This pg is part of spec PE-TS-426-673A-A001 94/500

S.No.	Description of Document	DESEIN				UPRVUNL			
		HO		SITE		HO		SITE	
		HC	CC	HC	CC	HC	CC	HC	CC
9.	Erection Manual 'Final'	1	1CD	1	-	1	1CD	2	1CD
10.	O&M Manual 'Draft'	3*	1CD	+	-	1	1CD	-	-
11.	O&M Manual 'Final'	1	1CD	1	-	1	1CD	2	2CD
12.	Commissioning Procedure 'Draft'	3*	1CD	-	-	1	1CD	-	-
13.	Commissioning Procedure 'Final'	1	1CC	1	-	1	1CD	2	1CD
14.	PG Test Procedure "Draft"	3*	1	-	-	1	1	-	-
15.	PG Test Procedure 'Final'	1	1 + 1 CD	1	-	2	1 + 1 CD	2	1 + 1CD
16.	Progress Report	3	1CD	1	-	2	1CD	1	1CD
17.	PG Test Report for Approval	4*	1	-	-	2	1 + 1 CD	-	-
18.	Approved PG Test Report	1	1 + 1 CD	1	-	2	1 + 1 CD	4	1 CD
19.	Project Completion Report	1	1 + 1 CD	1	-	1	1CD	1	1CD
20.	Vendor Details in respect of proposed vendors including Contractor's evaluation Report	1	1CD	-	-	1	1CD	-	-
21.	Monthly Vendor / QP Approval Status	1	1	-	-	2	1	1	1
22.	Manufacturing QPs, Field QPs for review / comments	6*	1	-	-	2	1CD	-	-
23.	Manufacturing QPs, Field QP, Final	1	1CD	1	-	2	1CD	2	1CD
24.	QA documents Package for equipment / field activities etc.	1	1CD	1	-	1	1CD	1	1CD

* - Consultant will return one (1) commented document to Vendor and CE (UPRVUNL), Lucknow
HC - Hard Copy
CC - Soft Copy thru e-mail
CD - CD ROM
HO - Head Office of Consultant / UPRVUNL

TITLE:
TECHNICAL SPECIFICATION FOR
SEWAGE TREATMENT PLANT
1X660 MW PANKI THERMAL POWER STATION EXT.
BHEL DOCUMENTS NO.: PE-TS-426-673A-A001
VOLUME II-B
SECTION-C1
REV. NO. 00
DATE:
This pg is part of spec PE-TS-426-673A-A001
95/500

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 sewage treatment plant area.
    - Equipment Cable tray layout for sewage treatment plant
    - Equipment earthing layout sewage treatment plant area
    - Civil scope drawings.
    - Piping lay out drawing for sewage treatment plant area and yard piping layout.
    - Valve schedule.
    - Instrument schedule.
    - Any Other Dwg/Docs as required.

ANNEXURE-V

MANDATORY SPARES

ANNEXURE-V

LIST OF MANDATORY SPARES FOR STP PLANT		
SL. NO.	**DESCRIPTION**	**TOTAL QUANTITY INCLUDED FOR THE PROJECT**
1	**LP PIPING**	
a.	**Valves** [Complete valve along with Actuators (pneumatic / hydraulic) and all other accessories which are the part of original supply shall be supplied]	5% of the total population (minimum 2 Nos) for each type, material, size and class, whichever is more.
2	**WATER SYSTEM**	
2.1	**Vertical Pumps**	
	Impeller	One No each for each type of pump
	Shaft (line shaft & vertical shaft)	One set for each type of pump
	Shaft Sleeves	One No each for each type of pump
	Impeller wearing rings	One No each for each type of pump
	Pump & Motor Bearings	One No each for each type of pump
	Shaft coupling	One set for each type of pump
	Gaskets	One set for each type of pump
	Bushes	One set for each type of pump
	Nuts and bolts	One set for each type of pump
2.2	**Horizontal Pumps**	
	Impeller	One no. each for each type of pump
	Shaft	One no. each for each type of pump
	Shaft Sleeves	One no. each for each type of pump
	Pump & Motor bearing	One no. each for each type of pump
	Packing rings	One no. each for each type of pump
	Oil Seals - one set (two nos.)	One no. each for each type of pump
	Mechanical seal	One no. each for each type of pump
2.3	**Metering Pumps / Dosing pumps**	
	Complete pump-motor set	One no. each for each type of Metering Pump
	Connecting Rod	One no. each for each type of Metering Pump
	Worm and worm wheel	One no. each for each type of Metering Pump
	Pump & Motor bearings	One no. each for each type of Metering Pump

2.4	**Agitator**	
	Agitator assembly with motor and gear box	One no. each for each type of Agitator
2.5	**Clariflocculator Bridge Mechanism**	
	For Flocculator Paddle Drive	
	Oil Seal (1 Set = 2 Nos.)	One set each for each type
	Bearings for gear box unit	One no. each for each type
	Bearings for Motor	One no. each for each type
	For End Carriage Drive	One no. each for each type
	Oil Seal (1 Set = 2 Nos.)	One set each for each type
	Bearings for gear box unit	One no. each for each type
	Bearings for Motor	One no. each for each type
	Chain & Socket for End carriage drive	One no. each for each type
	Bevel gear & Pinion set for flocculator drive	One no. each for each type
	Rubber squeeze for scraper blades	One no. each for each type
	Carbon brush for current collector assembly	One no. each for each type
	Central Bearing Assembly	One no. each for each type
	Telescopic Bleed Arrangement	One no. each for each type
2.6	**Blowers**	
	V Belt	One no. each for each type of blower
	Oil seal	One no. each for each type of blower
	Filter	One no. each for each type of blower
	Bearings (Blower & Motor)	One set each for each type of blower
	Impeller with Shaft & gear unit	One set each for each type of blower
2.7	**Diaphragm Valve**	
	Diaphragm	Five (5) Nos. of each size
2.8	Sampling & Needle valve	Four (4) Nos of each size
	Complete valve	Two (2) Nos. of each size
	Valve spindle	Two (2) Nos. of each size
2.9	Controller valve assembly complete	One (1) no. of each size
2.10	**Hoists**	
	Bearing	Two (2) sets of each size & type
	Brake linings	Two (2) sets of each size & type
	Rope guide	One (1) no. of each size & type
	Complete length of wire rope	One (1) no. of each size & type
2.11	**Electric Spares**	
	Contactors	One no. for each type & rating
	MCB	One no. for each type & rating
	Indicating Lamps	10% of installed
	ACB Spring Charge motor	One no. of each type
	Trip Coil	One no. of each type

	Closing Coil	One no. of each type
	Push Buttons	10% of installed
	Fuses	10% of installed
3	**415 V Motors**	
3.1	Terminal plates	10 Nos. each for small motors upto 30 kW & 4 Nos. each for more than 30 kW
3.2	Heaters	2 sets
3.3	Greasing arrangements	4 sets each type of motor
3.4	Motor of each type and rating	10% of the installed quantity or minimum 1 number whichever be higher
3.5	Bearings (DE and NDE) for each type and rating of motors.	4 sets
3.6	Stator winding coils for all type of LT motors	One (1) set
3.7	Dust seals and gaskets for each type of motors	Three (3) sets
4	**CONTROL & INSTRUMENTATION (MANDATORY SPARES)**	
4.1	**Measuring & Field Instruments**	
4.1.1	**Indicators, Recorders, Electrical Metering and Skid Mounted Instruments**	
(i)	Indicators, recorders and meters offered from each model for the project. These instruments shall be supplied with three sets of blank scales.	10 % of Installed of each type/Model or a minimum of one number for each model and type, whichever is more
(ii)	For skid mounted instruments	10% of total number of instruments for each Type and model or a minimum of one number for each model and type, whichever is more
(iii)	Panel and Wall mounted Indicators	10% of total number of instruments or a minimum of one number for each type, model, range etc. whichever is more
4.1.2	**Temperature Elements and Thermowells**	
(i)	Thermocouple/RTD elements	15% of flue gas temp, coal air mixture temp, boiler/TG metal temp thermocouples and 5% for other applications of total duplex thermocouple element assemblies and duplex RTD assemblies (with head assembly, terminal block and nipple) of each type and length whichever is more. The element assembly shall be suitable for direct replacement in the corresponding thermowell.
(ii)	Thermowells	10% for each type of temperature sensors or a minimum of one for each type & size, whichever is more

4.1.3	Temperature Transmitters and Electronic Transmitters of all type, range and model no. (For Pressure, DP, Temp, Flow, Level), Process Transmitters, Radar type level transmitter, 3D type level Transmitter with local display, Magnetic/Electromagnetic flow meter with local display, mass flow meter with local display., Process meters, Junction Box, Position Transmitter, Transducer or any other instrument etc.	10% of total number of instruments/transducers offered for each model and type, rating or a minimum of one number for each model, rating and type , whichever is more.
4.1.4	Process actuated switch Devices- As applicable for each package as per following:	5% of total nos. or 1 no. of each make, model, range and type whichever is more
	1. Temperature Switches	Refer comment above
	2. Differential pressure Switches	Refer comment above
	3. Pressure switches	Refer comment above
	4. Flow switches	Refer comment above
	5. Level Switches	Refer comment above
	6. Safety Protection Switches	Refer comment above
4.1.5	Local Gauges like temperature gauges, pressure gauges, differential Pressure gauges, flow gauges, flow meters with local display etc.	10% of total number of instruments/transducers offered for each model and type, rating or a minimum of one number for each model, rating and type , whichever is more.
4.1.6	All type of Rota meters & Sight Flow Indicator.	1 no. of each range and type
4.1.7	***PD Type*** flow transmitters with local display.	1 no. of each type and model
4.1.8	Guided wave RADAR for Hot well application	1 no.
4.1.9	Guided wave RADAR for LP heaters	1 no. for each of the LP heaters
4.1.10	Impact head type flow element	20% or 2 nos. of each make and type, whichever is more
4.1.11	Ultrasonic type flow measurement	20% or 2 nos. of each make and type, whichever is more
4.1.12	Ultrasonic type level transmitter	50% of each type and length, including sensors
4.1.13	Any other instruments not indicated in the tender P&ID but required for control, monitoring and operation of the equipment/plant/systems	10% or 2 nos. of each type whichever is more
4.1.14	**Level Gauges**	
	a) 10% or 2 nos. whichever is more of each type of illuminators with holder and reflector.	
	b) 20% or 5 nos. whichever is more of each type of bulb.	
	c) 10% or 2 nos. whichever is more of each type of bi-color rollers.	
	d) 10% or 2 nos. whichever is more of each type of glass along with pair of gaskets (cushion & wet gaskets).	
	e) 10% or 2 nos. whichever is more of each type of gaskets for gauge cocks/valve bonnet/ packing.	
	f) 10% or 2 nos. whichever is more of each type scale.	

4.1.15	Complete Electronic card/PCB assembly and Power supply card assembly.	10% of Electronic card/PCB assembly for each type, model & rating or a minimum of one number for each model, rating and type, whichever is more for each type of Transmitter, switch & Flow Meters.
4.2	**Relay based Control Panels**	
4.2.1	LEDs for indicating lights	100% of qty installed.
4.2.2	Control circuit fuses Semiconductor Fuses	300% of installed of each type, current rating.
4.2.3	MCB/MCCB	Ten percent spare replacement of each current rating required shall be furnished
4.2.4	Cooling Fans of each type, model and rating.	20% or 2 nos. of each type and rating, (whichever is more).
4.2.5	Relays modules & contactors.	20% spare of qty Installed of each type & rating.
4.2.6	Push buttons, ILPBs of each type.(complete with contact elements)	Ten (10) percent or 2 nos (whichever is more) of each type and color
4.2.7	Electric meter like Ammeters, Voltmeters etc.	Ten (10) percent or 2 nos (whichever is more) of each type
4.2.8	Control switches	5 nos. of each type and rating
4.2.9	Selector switches	1 no. of each type and rating
4.2.10	Any special meter	1 no. of each type and rating
4.2.11	Power supply modules.	Ten (10) percent or 2 nos (whichever is more) of each type
4.2.12	Control supply transformers	1 no. of each type and rating
4.3	**Mandatory Spares for Control valves, Power Cylinder, Control Dampers, Actuators, Flow Elements and Accessories**	
a)	One set of spare control valve stem packing for each control valve.	1 Set
b)	Two moulded rubber diaphragms for each control valve	2 Nos.
c)	100% of Diaphragms, O‑rings and rubber gaskets, seals for each type, make etc. of control valve.	100%
d)	100 percent qty. of lubricants for gaskets for each control valve on one year consumption basis.	100%
e)	2 sets of limit switches and 1 set of valve positioner for each control valve.	2 Sets
f)	20 percent of position transmitter (4‑20mA) and its accessories for total qty. of control valve.	20%
g)	One (1) set of valve trims (such as plug, stem, seat ring / cage, guide bushing, stem lock pin, packing retaining ring, etc) for each type of control valve.	1 Set
h)	One complete Pneumatic and electro-hydraulic actuato assembly of each type or min 10% for each type, model, rating and size whichever is more.	1 complete set or Min.10%
i)	20 percent of Solenoid valves or min 2 no. of each type for total qty. of control valves.	20% or min.2 nos. each
j)	20% of I to P converters, Pressure regulators.	20%

k)	10% or 2 nos. of each type whichever is more air lock relays	20% or min.2 nos. each
1.	Wherever quantity has been specified percentage (%) the quantity of mandatory spares to be provided by the bidder shall be type (as the case may be) in the same proportion of the main population. In case the quantity so calculated happens to be fraction, the same should distributed into various ranges /size /rating/next higher whole number.	
2.	Interchangeability and Packing: All spares supplied under this contract shall be strictly interchangeable with parts for which they are intended for replacements. These spares shall include all mounted accessories like components, boards, add or items, fittings, connectors etc. and be complete in all respects so that the replacement of the main items by these spares does not require additional item. All electronic modules should be preset and/or preprogrammed for ready use at site. Alternatively, suitable instruction sheet indicating details of required PCB jumper position, BCD which is setting, EPROM/ROM listing etc should be packed along with each module. Also a caution mark sign should be placed on all such module which needs presetting/ re programming before putting them in to service. The spare shall be treated and properly packed for long term storage.	
3.	Wherever quantity has been specified as percentage (%), it shall mean percentage (%) of the total population of the item in the station (project), unless specified otherwise and the fraction will be rounded off to the next higher whole number.	
4.	Wherever the quantities have been indicated for each type, size, thickness, material, radius, range etc. these shall cover all the items supplied and installed and the break up for these shall be furnished in the bid.	
5.	In case spares indicated in the list are not applicable to the particular design offered by the bidder, the bidder should offer spares applicable to offered design with quantities generally in line with the approach followed as per the above list.	
6.	Identification: Each spare shall be clearly marked and labeled 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.	

DRAWING No. PE-DG-426-673-A001

CUSTOMER'S DRAWING No.

FIRST ANGLE PROJECTION

ALL DIMENSIONS ARE IN MM

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COMPUTER FILE NAME:

SEWAGE SUMP (S-1) SEWAGE TRANSFER PUMPS (1W+1S) TYPE : VERTICAL SUMBERSIBLE PUMP

SEWAGE SUMP (S-2) SEWAGE TRANSFER PUMPS (1W+1S) TYPE : VERTICAL SUMBERSIBLE PUMP

SEWAGE SUMP (S-3) SEWAGE TRANSFER PUMPS (1W+1S) TYPE : VERTICAL SUMBERSIBLE PUMP

SEWAGE SUMP (S-9) SEWAGE TRANSFER PUMPS (1W+1S) TYPE : VERTICAL SUMBERSIBLE PUMP

SEWAGE SUMP (S-8) SEWAGE TRANSFER PUMPS (1W+1S) TYPE : VERTICAL SUMBERSIBLE PUMP

SEWAGE SUMP (S-11) SEWAGE TRANSFER PUMPS (1W+1S) TYPE : VERTICAL SUMBERSIBLE PUMP

SEWAGE SUMP (S-12) SEWAGE TRANSFER PUMPS (1W+1S) TYPE : VERTICAL SUMBERSIBLE PUMP

SEWAGE SUMP (S-4) SEWAGE TRANSFER PUMPS (1W+1S) TYPE : VERTICAL SUMBERSIBLE PUMP

SEWAGE SUMP (S-5) SEWAGE TRANSFER PUMPS (1W+1S) TYPE : VERTICAL SUMBERSIBLE PUMP

SEWAGE SUMP (S-6) SEWAGE TRANSFER PUMPS (1W+1S) TYPE : VERTICAL SUMBERSIBLE PUMP

SEWAGE SUMP (S-7) SEWAGE TRANSFER PUMPS (1W+1S) TYPE : VERTICAL SUMBERSIBLE PUMP

SEWAGE SUMP (S-10) SEWAGE TRANSFER PUMPS (1W+1S) TYPE : VERTICAL SUMBERSIBLE PUMP

FILTER, SILENCER, AIR BLOWER (2x100%) (1W+1S)

L E G E N D

	SPRING LOADED RELIEF VALVE
	GATE VALVE
	HORIZONTAL CENTRIFUGAL PUMP
	NON RETURN VALVE
PS	PRESSURE SWITCH
LAH LS	HIGH LEVEL SWITCH WITH ALARM
LAL LS	LOW LEVEL SWITCH WITH ALARM
	BUTTERFLY VALVE
PG	PRESSURE GAUGE
LS H	HIGH LEVEL SWITCH
LS L	LOW LEVEL SWITCH
	ALARM
	INTERLOCK
	DIAPHARM VALVE
FI	FLOW INDICATOR
	BALL VALVE
TI	TEMPERATURE INDICATOR
pH	PH INDICATOR
FS	FLOW SWITCH
	DIAPHRAGM SEAL
PS	PRESSURE SWITCH
	SUBMERSIBLE PUMP
	METERING PUMP
M	MOTOR
LI	LEVEL INDICATOR
TM	TURBIDITY METER
	RCC
	'Y' TYPE STRAINER
	PNEUMATIC OPERATED

SODIUM HYPO CHLORITE DOSING PUMPS (3X50%)

FILLGNG CONNECTION, SERVICE WATER, OVERFLOW, SODIUM HYPO CHLORITE TANK MOC: MSRL, DRAIN

DUAL MEDIA FILTER — TO EQUALISATION TANK

ACTIVATED CARBON FILTER — TO EQUALISATION TANK

MSRL PIPE

TREATED WATER TANK MOC:RCC

TREATED WATER DISPOSAL PUMP 2X100%(1W+1S) TYPE : HORIZONTAL CENTRIFUGAL PUMP

OVER FLOW TO PLANT DRAIN

TO NEAR BY PLANT DRAIN (emergency only)

TO GARDENING / HORTICULTURE

* PL. REFER TO NOTE REGARDING REQUIREMENT RELATED TO EMS BELOW.

RECIRCULATION LINE

COMMON COLLECTION SUMP MOC: RCC

COMMON COLLECTION SUMP PUMPS (1W+1S) TYPE : NON CLOG SUMBERSIBLE PUMP

OIL GREASE CHAMBER MOC: RCC

EQUALISATION TANK MOC: RCC

FAB/MBBR FEED PUMPS (1W+1S) TYPE : VERTICAL SUBMERSIBLE PUMP

FAB/MBBR TANK MOC: MSRL

TUBE SETTLER/ LAMELLA CLF MOC: MSRL

HYPO CONTACT/ FILTER FEED TANK MOC: PVC

MSRL PIPE

FILTER FEED PUMPS (1W+1S) TYPE : HORIZONTAL CENTRIFUGAL PUMP

OVER FLOW TO PLANT DRAIN

TO BE CONNECTED TO NEAREST ONWARD SUMP

SEWAGE SUMP (S-13) SEWAGE TRANSFER PUMPS (1W+1S) TYPE : VERTICAL SUMBERSIBLE PUMP
LOCATION TO BE DECIDED DURING DETAIL ENGG.

FILLGNG CONNECTION, SERVICE WATER, OVERFLOW, HYPO. DOSING TANK WITH 2-PUMPS (1W+1S) MOC: MSRL w. PVC, DRAIN

SEWAGE FROM REMOTE AREA BUILDINGS

TREATED WATER DISPOSAL PUMPS (SEPTIC TANK)

SEPTIC TANK WITH (TYPICAL) OVERFLOW SUMP
ST-1
ST-2
ST-3
ST-4

FILLGNG CONNECTION, SERVICE WATER, OVERFLOW, DISSOLVING BASKET

POLY ELECTROLYTE TANK MOC: PVC, DRAIN

POLY ELECTROLYTE DOSING PUMP (2X100%)

TO TANK

TO HORTCULTURE IN NEARBY AREA

SLUDGE SUMP MOC : RCC

SLUDGE TRANSFER PUMPS VERTICAL SCREW PUMPS 2X100% (1W+1S)

SLUDGE RECIRCULATION LINE TO MBBR TANK

CENTRATE TO EQUALISATION TANK

SLUDGE TROLLEY (IN BIDDER SCOPE)

CENTRIFUGE 1X100%

TO SEWAGE TREATMENT PLANT REQUIRED VALVES

OIL FILTER, BIDDER, BHEL, INSTRUMENT AIR

NOTES:

1. AIR BLOWER SHALL BE IN ACOUSTIC ENCLOUSER.
2. INSTRUMENTATION, VALVES, PIPING SHOWN IN P & ID ARE BARE MINIMUM REQUIREMENT. BIDDER HAS TO PROPOSE COMPLETE P & ID WITH ALL NECESSSARY INSTRUMENTATION (ALONG WITH REQUIRED REDUNDANCY), PIPING AND VALVES FOR SAFE AND TROUBLE FREE OPERATION.
3. CUSTOMER : UPRVUNL.
4. EQMS INSTRUMENTS FOR STP SHALL BE PROVIDED BY BIDDER WITH PROVISION FOR BIDIRECTIONAL CONNECTIVITY OVER MODBUS/RS-232/RS-485 WITH EMPLOYERES CENTRAL CLOUD SERVER/EQMS FOR REAL TIME DATA MONITORING, REMOTE DIAGNOSTICS & REMOTE CALIBRATION CHECKS, ETC. ALL NECESSARY HARDWARE AND SOFTWARE REQUIRED AT INSTRUMENT END SHALL BE PROVIDED BY THE CONTRACTOR.
5. DEPTH OF SUMP MAY VARY FROM 2-4 METERS FROM FGL
6. AS PER STATUTORY REQUIREMENT IF SEPTIC TANKS ARE NOT ACCEPTABLE, BIDDER TO PROVIDE ALTERNATE EQUIVALENT SYSTEM/ ARRANGEMENT.

CUSTOMER: UTTAR PRADESH RAJYA VIDYUT UTPADAN NIGAM LIMITED

CONSULTANT: DEVELOPMENT CONSULTANTS PRIVATE LIMITED

PROJECT: 1 X 660 MW PANKI THERMAL POWER STATION

JOB NO. 426
STATUS CONTRACT
DISTRIBUTION

REV.	DATE	ALTD	CHD	APPD

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA

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DEPT CODE	NAME	SIGN	DATE
DRN	PC		16-08-2019
DES'N	VK		16-08-2019
CHD	SB		16-08-2019
APPD	AK		16-08-2019

TITLE: P&I DIAGRAM FOR SEWAGE TREATMENT PLANT

DEPT. SCALE NTS SIGN

DRAWING NO. PE-DG-426-673-A001

SHEET 1 OF 1 REV. 0

SIZE-A0

DRAWING NO. PE-DG-426-100-M001

FIRST ANGLE PROJECTION

ALL DIMENSIONS ARE IN MM.

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Canal
Canal
To Kalyanpur
Village Mircapur
TOWNSHIP
43
44
ST-3
ST-2
S-12
S-11
S-10
S-9
S-8
S-7
S-6
S-5
S-4
S-3
S-2
S-1
ST-1
ST-4
RAW WATER RESERVOIR
Area=317005q.m (approx.)
Area=317005q.m (approx.)
400 K.V. Sub Station
220 K.V. Sub Station
(DHEL Office)
(DHEL School)
Back Ash Plant
PAVED AREA
NDCT
CHIMNEY
PH
PLANT
STP
Village Site Ratanpur
Village Site Ratanpur
Village Site Ratanpur
Village Site Ratanpur
Village Site Ratanpur
Flay Ash Pond
Flay Ash Pond
Tributary
Tributary
To Kalyanpur
To Kalyanpur
Tank
Tank
Tank

DATASHEET–A FOR STP

Sl. No.	DESCRIPTION	
1.0	**Capacity of STP**	40 m3/day
2.0	**Common Collection Sump**	
i)	Numbers Required	One (1) no.
ii)	Capacity	2.0 m3 /As per system requirement
iii)	MOC	RCC
iv)	Type of Aeration	Coarse Bubble Diffused Aeration Type
v)	Type of Diffusers	Coarse bubble diffusers with retrievable arrangement
vi)	No. of Diffusers	As per system requirement
vii)	No. of chain pulley block/electric hoist and capacity	One no., chain pulley bock or electrical hoist as per specification requirement, capacity as per specification requirement.
viii)	Handrail	To be provided by bidder
3.0	**Common Collection Sump Pumps**	
i)	Numbers Required	2 nos. (1W+1S)
ii)	Type	Submersible grinder type
iii)	Flow	2.0 m3/hr (minimum)
iv)	Head	As per process requirement
v)	Particle Size	Up to 20 mm
vi)	MOC	Casing- Cast Iron to IS 210 FG 260 Impeller- SS316, Shaft-SS316
vii)	Drive Motor	Induction motor, 415V, 3 Φ, 50 Hz, TEFC, Energy Efficiency Class IE-3 as per IS : 12615
4.0	**Screen Chamber**	
i)	Numbers required	1 no. (1W+0S)
ii)	Bar screen chamber MOC	RCC
iii)	Bar screen chamber capacity	As per process requirement
iv)	Type	Perforated sheet
v)	Cleaning	Manual
vi)	Angle of inclination	60°
vii)	Bar MOC	SS-304 fitted with MS frame
viii)	Velocity	<1.0 m/sec
ix)	Spacing of bar`	10 mm
5.0	**Oil & Grease chamber**	
i)	Numbers required	1 no.
ii)	Oil & grease chamber MOC	RCC
iii)	Oil & grease chamber capacity	As per process requirement

6.0	**Oil & Grease Trap**	
i)	Numbers Required	One (1) no.
ii)	Flow (m3/hr)	2 m3/hr
iii)	MOC	RCC with baffle arrangements
iv)	Perforated pipe MOC	PVC/CS
7.0	**Equalization Tank**	
i)	Numbers Required	1 no.
ii)	Flow (m3/hr)	2 m3/hr. As per process requirement
iii)	Detention Time	4 hours (min)
iv)	MOC of Tank	RCC
v)	Depth	2.5 -4.0 m. As per system requirement
vi)	Type of Aeration	Coarse Bubble Diffused Aeration Type
vii)	Type of Diffusers	Coarse bubble diffusers with retrievable arrangement
viii)	No. of Diffusers	As per system requirement
ix)	No. of chain pulley block/electric hoist and capacity	One no., chain pulley bock or electrical hoist as per specification requirement, capacity as per specification requirement.
x)	Handrail	To be provided by bidder
8.0	**Common Air Blowers for Equalization Tank /Sludge Sump /Common Collection Sump**	
i)	Numbers Required	2 nos. (1W+1S)
ii)	Type of Blower	Twin lobe type
iii)	Flow	To cater Air requirement for Equalization tank & Sludge Sump & Common Collection Sump
iv)	Head	As per process requirement
v)	MOC	CI to IS 210 Gr. FG 260
vi)	Accessories	NRV, Pressure Gauge, Safety valves, Silencer, PRV, Filter, etc.
vii)	Drive Motor	Induction motor, 415V, 3 Φ, 50 Hz, TEFC, Energy Efficiency Class IE-3 as per IS : 12615
viii)	Common Base plate/ mounting plate	MS as per IS 2062
9.0	**FAB/ MBBR Feed Pumps**	
i)	Numbers Required	2 nos. (1W+1S)
ii)	Type	Vertical Submersible Grinder type Pumps
iii)	Flow	2.0 m3/hr (min)
iv)	Head	As per process requirement
v)	MOC	Casing – Cast Iron to IS 210 FG 260 Impeller & shaft - SS304
vi)	Particle Size	Up to 20 mm
vii)	Drive Motor	Induction motor, 415V, 3 Φ, 50 Hz, TEFC, Energy Efficiency Class IE-3 as per IS : 12615

10.0	**FAB/ MBBR Reactor**	
i)	Numbers Required	One(1) no.
ii)	Flow (m3/hr)	2 m3/hr
iii)	Food to Microorganism(F/M) Ratio	0.1-0.15 Kg BOD/ Kg MLSS/ day
iv)	MLSS (Mixed Liquor Suspended Solids)	3000-6000 mg/l
v)	MOC of Tank	MSRL
vi)	Depth	Minimum 4-5 m
vii)	Type of Aeration	Fine Bubble Diffused Aeration Type
viii)	Type of Diffusers	Silicon based fine bubble diffusers with retrievable arrangement
ix)	No. of Diffusers	As per system requirement
x)	Media	PVC
xi)	Media Qty	As per system requirement
xii)	Free Board	500 mm
xiii)	Volume (in m3)	As per process requirement
11.0	**Air Blowers for FAB/ MBBR Tank**	
i)	Numbers Required	2 nos. (1W+1S)
ii)	Type of Blower	Twin lobe type
iii)	Flow	To cater Air requirement for aeration tank
iv)	Head	As per process requirements
v)	MOC	CI to IS 210 Gr. FG 260
vi)	Accessories	NRV, Pressure Gauge, Safety valves, Silencer, PRV, Filter etc.
vii)	Drive Motor	Induction motor, 415V, 3 Φ, 50 Hz, TEFC, Energy Efficiency Class IE-3 as per IS : 12615
viii)	Common Base plate/ mounting plate	MS as per IS 2062
12.0	**Tube settler / Secondary Settler**	
i)	Numbers Required	One (1) no.
ii)	Flow (m3/hr)	2 m3/hr (min)
iii)	Surface flow rate	2 m3/ m2/hr.
iv)	MOC of settler	MSRL
iv)	Quantity of tube settler media	As per process requirement
v)	MOC of media	PVC
vi)	Free board	500 mm
13.0	**Hypo Contact Cum Filter Feed Tank**	
i)	Numbers Required	One (1) no.
ii)	Capacity	As per Process requirement
iii)	MOC	PVC
iv)	Make	Sintex
v)	Handrail	To be provided by bidder
14.0	**Hypo Dosing System**	
14.1	**Hypo Dosing Tank**	
i)	Numbers Required	Five (5) no. (4 nos. for septic tanks & 1 nos. for Hypo contact Filter Feed tank/Centrifuge feed line)
ii)	Capacity	As per process requirement. 200 liters OR 24 hour storage requirement @ suitable dosing rate whichever is higher
iii)	MOC	MSRL/ PVC

14.2	**Hypo Dosing Pump**	
i)	Quantity	Seven (7) no. (4 nos. for septic tanks & 3 nos. for Hypo contact Filter Feed tank/Centrifuge feed line)
ii)	Capacity	As per process requirement. 0-6 LPH or 2 ppm continuous dosing rate requirement whichever is higher
iii)	Type	Metering Pump
iv)	Make	As per approved vendor
iv)	MOC	PP
v)	Drive Motor	Induction motor, 415V, 3 Φ, 50 Hz, TEFC, Energy Efficiency Class IE-3 as per IS : 12615
15.0	**Filter Feed Pumps**	
i)	Quantity	Two (2X100%) nos. (1W+1S)
ii)	Type & Operation	Horizontal Centrifugal, Continuous
iii)	Suction condition	Flooded.
iv)	Capacity	Approx. 2.0 m3/hr / as per process requirement
v)	Head	As per process requirement
vi)	Material of Construction	
	• Casing	Cast Iron IS:210 Gr FG 260
	• Impeller	Stainless steel CF 8M
	• Shaft & Shaft sleeve material	Stainless steel SS Gr. 304 & SS316
	• Packing seal	Mechanical type
	• Drive motor	Induction motor, 415V, 3 Φ, 50 Hz, TEFC, Energy Efficiency Class IE-3 as per IS : 12615
	• Common base plate	Carbon steel IS:2062
vii)	Noise level	85 DBA
viii)	Vibration	As per HIS
ix)	RPM	1500 approx.
x)	Drive motor	Induction Motor 415V, 3 Phase, 50 Hz, TEFC, Energy Efficiency Class IE-3 as per IS : 12615
xi)	Interconnecting Piping Material	Carbon Steel with Rubber lining.
16.0	**Dual Media Filter**	
i)	Quantity	1 no.
ii)	Capacity	2 m3/hr.
iii)	Surface flow rate	10 m3/hr./m2
iv)	Size	As per process requirement
v)	Design pressure	Shut off head of pump + 5% margin
vi)	MOC	Epoxy Coated carbon steel
vii)	Media	Graded quartz sand free from carbonates/other foreign material and Anthracite.
viii)	Rising Space(Free board)	100 %
ix)	Make	As per approved vendor
17.0	**Activated Carbon Filter**	
i)	Quantity	1 no.
ii)	Capacity	2 m3/hr.

iii)	Surface flow rate	15 m3/hr./m2
iv)	Size	As per process requirement
v)	Design pressure	Shut off head of pump + 5% margin
vi)	MOC (Shell & Dish)	Epoxy Coated carbon steel
vii)	Media	Activated Carbon
viii)	Supporting Media	Graded Gravel
ix)	Minimum Bed depth	1200 mm
x)	Rising Space(Free board)	100 %
18.0	**Treated Water Tank**	
i)	Number required	1 no.
ii)	Capacity (Effective)	As per system requirement
iii)	Flow	2 m3/hr (min)
iv)	Detention Time	8 Hrs.
v)	MOC of tank	RCC
vi)	Depth	2.5 m- 4 m
vii)	Handrail	To be provided by bidder
19.0	**Treated Water Disposal Pumps**	
i)	Quantity	Two (2) nos. (1W+1S) 100%
ii)	Type & Operation	Horizontal Centrifugal, Continuous
iii)	Suction condition	Flooded.
iv)	Capacity	4.0 m3/hr.
v)	Head	As per process requirement
vi)	Material of Construction	
	• Casing	Cast Iron IS:210 Gr FG 260
	• Impeller	Stainless steel CF 8M
	• Shaft & Shaft sleeve material	Stainless steel SS Gr. 304 & SS316
	• Packing seal	Mechanical type
	• Common base plate	Carbon steel IS:2062
vii)	Noise level	85 DBA
viii)	Vibration	As per HIS
ix)	RPM	1480
x)	Drive motor	Induction Motor 415V, 3 Phase, 50 Hz, TEFC, Energy Efficiency Class IE-3 as per IS : 12615
xi)	Interconnecting Piping Material	Carbon Steel with Rubber lining.
20.0	**Sludge Sump (waste Pit)**	
i)	Number required	1 no.
ii)	MOC & type	RCC, Under Ground, Outdoor Location
iii)	Capacity (Effective)	As per Process requirement
iv)	Instrumentation	Level Switch with indication on Panel /As per P&ID
v)	Inside Protection	5 mm thick coal tar epoxy screened lining

vi)	No. of chain pulley block/electric hoist and capacity	One no., chain pulley bock or electrical hoist as per specification requirement, capacity as per specification requirement.
vii)	Handrail	To be provided by bidder
21.0	**Sludge transfer Pumps**	
i)	Quantity	Two (2) nos. (1W+1S) 100%
ii)	Type	Horizontal Screw Pumps
iii)	Location	Outdoor
iv)	Service	Intermittent
v)	Suction condition	Flooded.
vi)	Rated Flow	As per process requirement approx. 2 m3/hr whichever is higher.
vii)	Head	As per process requirement
viii)	Type of fluid handled	Sludge from Clarifier
ix)	Material of Construction	
	• Casing	2% Ni-CI to IS:210 Gr FG 260
	• Rotor	SS-316
	• Stator	Nitrile/EPDM
	• Shaft	SS-316
x)	Noise level	85 DBA
xi)	Vibration	As per HIS
xii)	RPM	1500 Approx.
xiii)	Drive motor	Induction Motor 415V, 3 Phase, 50 Hz, TEFC, Energy Efficiency Class IE-3 as per IS : 12615
22.0	**Centrifuge**	
i)	Quantity	One (1) number
ii)	Type	Decanter
iii)	Inlet concentration	2%
iv)	Outlet concentration	20% (min.)
v)	Capacity	As per process requirements
vi)	Liquid handled	Secondary sludge
vii)	Material of construction	Wetted parts: SS304 Other parts : MSEP/CI
viii)	Motor	IP-55 with outdoor installation, 3-phase, 415V, TEFC type squirrel cage induction motor, Rating as per requirement, Energy Efficiency Class IE-3 as per IS : 12615; Hydraulic coupling to dampen the initial acceleration.
ix)	Base Frame	MS Fabricated
x)	Accessories	Screening at inlet, Suitable piping, valves, pressure gauge at delivery pulley, V-belt drive, foundation bolts etc.
xi)	No. of electric hoist and capacity	One no., Capacity as per specification requirement.
	Note: Suitable polyelectrolyte dosing tank (MOC-PVC/HDPE, Cap: 100ltr) along with two (2) no, (1W+1SB) dosing pumps, Capacity to suit process requirement, to be provided for dosing before centrifuge.	
23.0	**Sewage Sumps (Outside STP Area)**	
i)	Sewage sump S1, S2, S3, S4, S5, S6, S7, S8, S9, S10, S11, S12, S13	Capacity as per P&ID / System requirement
ii)	MOC	RCC

iii)	Type	Covered at top, below ground
iv)	Accessories	Coarse bar screen (MOC : SS-304) at each sump location
v)	Handrail	To be provided by bidder
vi)	No. of chain pulley block/electric hoist and capacity	One no. at each sump location , chain pulley bock or electrical hoist as per specification requirement, capacity as per specification requirement.
24.0	**Sewage Transfer Pumps(Outside STP Area)**	
i)	Type	Vertical submersible grinder type,
ii)	Quantity per sump	2 X 100 %
iii)	Capacity	As per P & ID of Sewage Treatment plant
iv)	MOC casing	Cast Iron to IS 210 FG 260
v)	MOC impeller	Stainless Steel AISI 304
vi)	MOC shaft	SS 410
vii)	Drive Motor	Induction motor, 415V, 3 Φ, 50 Hz, TEFC, Energy Efficiency Class IE-3 as per IS : 12615

Further bidder to provide 1 no. Common chain pulley block (portable type) for handling of filter feed pump & treated water disposal pumps alongwith motor as per specification requirement, capacity shall be selected based on heaviest pump with motor weight from the above listed two drives & as per specification requirement.

For piping and valves specification bidder to refer specification of LP PIPING, VALVES & SPECIALITIES Included under section II-A mechanical of this technical specification.

PUMPS AND PIPE SELECTION CRITERIA

Pump and Pipeline carrying water and chemicals etc. shall generally be sized on the following velocities. However wherever minimum pipe sizes are defined in the drawing/datasheets, the selected size shall not be less than the specified size.

	VELOCITY IN m/sec.		
	BELOW 50 MM.	**50-150 MM**	**200 MM AND ABOVE**
Pump Suction for water	------	1.2-1.5	1.2-1.8
Pump discharge for water	1.2-1.8	1.8-2.4	2.1-2.5
Header for water	-------	1.5-2.4	2.1-2.4
Pump Suction for chemical solution	1.0-1.2	1.1-1.3	-------
Pump discharge for chemical solution	1.2-1.4	1.3-1.5	--------
Gravity flows	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.		

Note 1- All piping system shall be capable of withstanding the maximum pressure in the corresponding line.

Note 2- TDH of all pumps shall be decided by the supplier assuming the following 'C values in Hazen & Williams equation for calculation of friction loss.

a) **Carbon steel pipes – 100**
b) **CI Pipes /Ductile Iron pipes –100**
c) **Rubber lined steel pipe – 120**
d) **PVC/HDPE pipes – 140**
e) **Stainless steel pipes -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.

TECHNICAL DATASHEET-A FOR ELECTRIC HOIST:

Sl.no	DESCRIPTION	TECHNICAL PARTICULARS
1.0	Type	Steel wire electric hoist with electrically operated trolley
2.0	Scope (Qty., Capacity, Lift, Travel Length)	As per specification and layout requirement
3.0	Type of service	Indoor
4.0	Overload test	125% of SWL
5.0	Design Ambient temperature	50° C
6.0	General Design	As per IS: 3938 / 1983 or latest, Class-II duty
6.1	Design standards	IS: 3938, IS: 2266,IS: 4029, IS: 900,IS: 4237, IS: 694, IS: 3043, IS: 1822, IS: 2147. IS: 1554, IS: 325, IS: 15660, IS 9968 Part I etc as per latest revision
6.2	Duty class	Class II duty
7.0	Operating speed	
7.1	Hoisting speed	3 MPM
7.2	Trolley speed	6 MPM
8.0	Type of transmission	Through Electric motor and gear box.
9.0	Wire Rope	
9.1	Construction / core	6 x36 construction, steel core/Fibre core

9.2	Code	IS:2266
9.3	Number of falls	Min. 4
9.4	Factor of safety	Not less than 5
10.0	Load Hook and block	NORMALISED HOOK ONLY
10.1	Type of load hook	Plain shank trapezoidal section with safety latch.
10.2	Load hook Code	IS: 15560
10.3	Load hook Material	As per IS:15560
10.4	Hook suspension	Thrust bearing
10.5	Material of block suspension	Fabricated from steel plate, Material: IS: 2062
11.0	Gearing	
11.1	Type	Spur / Helical
11.2	Gear/ pinion material	as per IS 3938
11.3	Lubrication	Oil splash/ grease lubricated
11.4	Bearing type	Antifriction Ball / Roller
12.0	Trolley drive	
12.1	Wheel	Single flange taper thread
12.2	Wheel conform to (Std. / code)	IS: 3938
12.3	Wheel material	C55Mn75/ En-8/ En-9. (Max hardness 200 BHN)
12.4	Bearing type	Antifriction Ball / Roller
12.5	Trolley type	Rolled structural steel with side plates extended beyond wheel flanges to protect wheels.
12.6	Hardness	Max hardness 200 BHN
13.0	SHEAVE	
13.1	Material	Fabricated from steel plate. IS: 2062 Gr. A or Gr. B / as per IS: 3938
13.2	Bearing type	Antifriction Ball / Roller.
14.0	BRAKE (HOIST and TROLLEY)	
14.1	Type	DCEM brakes disc type (fail to safety).
14.2	Capacity	As per IS 3938.
14.3	Number	One number for each motor.
15.0	ROPE DRUM	
15.1	Material	Cast iron, cast steel or mild steel.

15.2	Flange / Flangeless	Flanged	
15.3	Type of groove	As per manufacturers standard to suit the layout requirement.(Shall be decided during detail engineering)	
17.0	TYPE OF DSL		
17.1	CT travel	PVC Shrouded bus bar conductor type DSL	
18.0	MOTORS		
18.1	Type	Sq. Cage induction, TEFC, S4 duty, 40% CDF.	
18.2	Number of start	300 starts / hr	
18.3	Voltage , Phase and Frequency	415V ±10%, 3 phase, 4 wire, 50 Hz	
18.4	Class of insulation	Class "F" and temperature rise limited to class B.	
18.5	Type of enclosure	TEFC	
18.6	Degree of protection provided for enclosure	IP-54/55 (indoor/outdoor)	
18.7	Margin	10% over maximum continuous load demand	
19.0	LIMIT SWITCHES	Hoisting	Trolley
19.1	Type	Snap action, self actuating type	Lever type
20.0	Control panel	* Fabricated from Cold rolled sheet steel not less than 2.5mm for front & rear & 2mm for side, top & bottom portion with gland plate of 3mm thick. * Degree of protection shall be IP 54. * Power on indicating lamps shall be provided * Panel illumination lamps operated by door switch. * 2 nos earthing terminals on panel. * 20 % spares terminals (clip on type) shall be provided. * Power and control terminals (clip on type) shall be on separate channels. * Gland plate shall be double brass compression type.	
20.1	Qty	1 No.	
21.0	Pendent Push buttons	Up /down / forward / Reverse push buttons. Indicative marking for easy operation shall be provided.	
22.0	Power cables	1.1 KV grade XLPE power cables shall have compacted aluminium conductor for cables including 10 sq. mm and above and copper conductor for cables below 10 sq.mm, XLPE insulated, PVC inner-sheathed (as applicable), armoured, FRLS PVC outer-sheathed conforming to IS: 7098. (Part-I).	
23.0	Control cable	Control cable shall be multi core, minimum 2.5 sq.mm cross section, stranded copper conductor, PVC insulated, inner PVC sheathed / galvanized steel wire armored and outer sheath made of FRLS PVC compound. In situation where accuracy of measurement or voltage drop in control circuit, warrant, higher cross sections as required	

		shall be used. 4 sq.mm copper conductors shall be used for CT circuits, all other specification remaining same. In 4 sq.mm conductor impose unacceptable high burden on CTs, higher cross section of conductor shall be used.
24.0	Flexible trailing cable	1.1 KV grade Trailing cables shall have tinned copper (class 5) conductor, insulated with heat resistant elastomeric compound based on Ethylene Propylene Rubber (EPR) suitable for withstanding 90°C continuous conductor temperature and 250 deg C during short circuit, inner-sheathed with heat resistant elastomeric compound, nylon cord reinforced, outer-sheathed with heat resistant, oil resistant and flame retardant heavy duty elastomeric compound conforming to IS 9968
25.0	Control Voltage	110 V

B) MANUAL HOIST (CHAIN PULLEY BLOCK):

DATA SHEET-A

1.00.00	Type	:	Hand operated chain pulley block
2.00.00	Area	:	As per scope sheet attached
3.00.00	Design	:	IS: 3832, IS: 2429, IS 15560, IS 210, IS 4367, IS 6216, IS: 4460. (All standards shall be of latest revision)
4.00.00	Duty Class as per IS:3832	:	Class –II
5.00.00	Hoisting Mechanism		
a)	Type	:	Hand operated gear transmission
b)	Type of gear	:	Spur / Helical
c)	Load Chain	:	
	i) Type	:	Link type
	ii)Material	:	Alloy steel grade 80 as per IS: 6216
	iii) Conforms to (Std./Code)	:	IS: 6216
d)	Hand Chain	:	
	i) Type	:	Link type
	ii) Material	:	Mild steel (grade 30) as per IS 2429 Part I
e)	Load Hook & Hook Block	:	
	i) Type of load hook	:	Plain shank- Trapezoidal section
	ii) Load hooks conform to / Material	:	IS: 15560
	iii)Type of hook suspension	:	Swivelling
	iv)Type of make of bearing of hook suspension	:	Thrust ball bearing

f)	Gears/pinion	:	
	i) Type	:	Spur
	ii) Material	:	Alloy steel / carbon steel (Material confirming to IS 3832)
	iii) Type of bearing used	:	Antifriction ball bearing / Roller
g)	Sprockets		
	i) Type of bearings used	:	Antifriction ball bearing / Roller
h)	Method of lubrications Used		
	i) Bearings	:	Grease
	ii)Gearing & Pinions	:	Grease
	iii)Sprockets	:	Grease
i)	Brakes		
	i) Type	:	Ratchet and pawl arrangement along with screw and friction disc type
6.00.0	Trolley & Bridge Drive		
a)	Trolley		
i)	Type	:	Geared (Manually operated)
ii)	Material of frame	:	Rolled structural steel (IS:2062 Grade A or B)
b)	Drive Chain		
i)	Type	:	Link type
ii)	Material	:	Steel Gr.30
c)	Trolley Wheel		
i)	Number of pairs of wheel in each trolley/bridge	:	Two/four
ii)	Flange	:	Single flanged
iii)	Wheel material	:	Heat Treated Carbon steel/low alloy steel/graded cast iron (Material confirming to IS 3832)
iv)	Type of bearings need	:	Antifriction
d)	Gears		
	i) Type	:	Spur / helical
	ii) Material	:	Alloy/ Carbon steel (Material confirming to IS 3832)
	iii) Type of bearings used	:	Antifriction
e)	Method of lubrication for		
	i) Bearings	:	Grease
	ii) Sprockets	:	Grease
f)	Load chain wheel		
	i) Material	:	SG iron/ Steel casting/IS 3832
g)	Hand chain wheel		
	i) Material	:	SG iron/ Steel casting/Grey iron Casting./IS 3832

TECHNICAL SPECIFICATION

FOR
SEWAGE TREATMENT 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 **SEWAGE TREATMENT 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.
i) Vendor to clearly indicate equipment locations and local routing lengths in their cable listing furnished to BHEL.
j) Cable BOQ worked out based on routing of cable listing provided by the vendor for " both end equipment in vendor's scope"shall be binding to the vendor with +10 % margin to take care of slight variation in routing length & wastages.

a. EQUIPMENT & SERVICES TO BE PROVIDED BY PURCHASER FOR ELECTRICAL & TERMINAL POINTS:

Refer "Electrical Scope between BHEL and Vendor".

2.0 DOCUMENTS TO BE SUBMITTED ALONG WITH BID

2.1 The electrical specification without any deviation from the technical/quality assurance requirements stipulated shall be deemed to be complied by the bidder in case bidder furnishes the overall compliance of package technical specification in the form of compliance certificate/No deviation certificate.

2.2 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.

2.3 Enclosed quality plan of motor is tentative and subject to approval of NTPC/BHEL during detailed engineering with out any commercial implication to BHEL.

3.0 List of enclosures :

a) Electrical scope between BHEL & vendor

b) Customer (M/s DCPL) specification for Motors

c) Customer (M/s DCPL) cabling spec (to be referred by vendor for their scope of work (as per Electrical scope between BHEL & vendor)).

d) Quality plan for motors

e) Datasheet (Annexure- I)

f) Datasheet-C

g) Electrical Load data format (Annexure –II)

h) BHEL cable listing format (Annexure –III).

i) List of Mandatory Spares (Refer Annexure V of Section C1)

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR (FOR EPC PROJECTS)

PACKAGES: SEWAGE TREATMENT PLANT

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 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 or any other size 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 or any other size 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 control cables.

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR (FOR EPC PROJECTS)

PACKAGES: SEWAGE TREATMENT PLANT

SCOPE OF VENDOR: SUPPLY, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT

PROJECT:

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
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.
18	Electrical Equipment GA drawing	Vendor	-	For necessary interface review.

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR (FOR EPC PROJECTS)

PACKAGES: SEWAGE TREATMENT PLANT

SCOPE OF VENDOR: SUPPLY, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT

PROJECT:

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.

CHAPTER 17 : AC & DC MOTORS

1.00 MOTORS

1.1 SCOPE

This specification is intended to cover design, manufacture, assembly and testing of AC Squirrel Cage Induction Motors for use in Thermal Power Plants and is supplement to the driven equipment specifications under which these motors are being procured for the project.

SITE CONDITIONS

Site conditions are covered in 'Project Data', contained in specification of the driven equipment.

1.2 Gases, Fumes & Dust Particles

1.2.01 General - Sulphur dioxide and/or trioxide fumes mildly present. Climate is tropical, conducive to fungus growth.

1.2.02 **Dust Particles**

1 Outdoor locations - Heavily dusty with abrasive dust and coal particles of size five (5) to hundred (100) microns present in atmosphere in large quantity.

2 Indoor Locations.

2.1 Coal conveyors - As for outdoor as per clause 1.02.02.1 above.

2.2 Other locations - Lightly dusty with abrasive dust and coal particles of size five (5) to twenty (20) microns present in atmosphere.

1.2.03 **Special Fumes**

1 Water treatment plant and acid cleaning room - Acid and alkali fuses present.

2 Fuel oil pumping areas & Hydrogen generation plant - Explosive fuses (flameproof motors required).

1.2.04 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.

1.3 **LOCATION OF MOTOR** - As required

1.4 **SPECIFICATIONS & STANDARDS**.....Motors shall comply with the latest revisions of all relevant standards of BIS (IS-325, IS-900, IS-996, IS-1231, IS-1885, IS-2148, IS-2223, IS-2253, IS-2254, IS-2848, IS-3202, IS-4029, IS-4691, IS-4722, IS-4728, IS-4889, IS-6362, IS-7816, IS-8223, IS-8789 , IS: 12615, IS:3177 and IEC : 60034 3Φ Induction motor) except as modified herein or in driven equipment specification.

Motors conforming to BS or IEC Publications, which ensure equivalent quality shall also be acceptable.In case of any difference between IS Specification/International Standards (IEC; NEMA etc.), this motor specification prevails.

1.5 TYPE

1.5.1 AC Motors:

a) Squirrel cage induction motor suitable for direct-on-line starting.

b) Continuous duty LT motors upto 160 KW Output rating (at 50 deg. C ambient temperature), shall be **Efficiency class-**IE3 conforming to IS 12615, or IEC:60034-30.

c) Crane duty motors shall be slip ring/ squirrel cage Induction motor as per the requirement.

1.5.2 DC Motors Shunt wound.

1.6 **VOLTAGE (NOMINAL)**

1.6.1 **LV Motors**

For motors upto and including 200 KW - Four hundred fifteen (415) V.

1.6.2 **MV MOTORS**

For motors above 200kW upto and including 1500kW, Three point three (3.3) kV.

For CHP conveyors motor above 160 kW, 3.3 kV, AC supply is to be used. However all the motors on stacker reclaimer shall be on 415 V AC only.

1.6.3 **HV Motors**

For motors above 1500kW - eleven(11) KV

1.6.4 All motors are to be designed for system grounding described in "System Particulars" under site information of the Driven Equipment Specification.

1.7 **FREQUENCY (NOMINAL)** - fifty (50) Hertz

1.8 NUMBER OF PHASES - Three (3)

1.9 SPEED - As required by the driven equipment

1.10 TYPE OF STARTING :

Direct on-line (VFD/Soft-starter/star/delta starting in special cases)

1.11 DUTY

1.11.1 Continuous motor rating shall be arrived at considering 15% margin over the duty point input or 10% over the maximum demand of the driven equipment,

whichever is higher, considering highest system frequency and voltage variation. Crane motors shall be rated for S4 duty, 40% cyclic duration factor. If however, a higher margin is stipulated in the accompanying driven equipment specification, the higher stipulated margin shall prevail.

1.11.2 All HT motors shall have vibration pads for mounting vibration detectors.

1.11.3 All motors shall be designed to withstand hundred twenty (120) percent of rated speed without any mechanical damage for two (2) minutes.

1.11.4 Motors shall be designed to keep torsional and rotational natural frequencies of vibration of the motor and driven equipment atleast twenty five (25) percent above or below, preferably above the motor operating speed (to avoid resonance in vibration over the operating speed) range.

1.11.5 All LV motors rated 0.37kW and higher with S1 duty shall be compulsorily be of energy efficiency level IE 2 as per IS 12615:2011.

Motors rated above 37kW shall have efficiency higher than 0.92 and high power factor of atleast 0.88.

1.12 SUPPLY VARIATIONS

Motors shall be capable of running continuously at full load under following variations in power supply:

1.12.1 All equipments shall be suitable for rated frequency of 50 Hz with a variation of (+) 3% and (-)5%, voltage variation of ($\pm$) 6% for 11 kV & 3.3 kV and ($\pm$)10% for 415V and 10% (absolute sum) combined variation of voltage and frequency unless specifically brought out in the specification.

1.13 ABNORMAL CONDITIONS CAPABILITY

Motor shall have following capabilities as specified design ambient temperature:

1.13.1 The motors shall also be capable of running up again after voltage collapse to about 40% for approximate duration of 0.5 sec. Subsequent rise in voltage to 70% and further to 80% and 100%, the total duration not exceeding 20 sec.

1.13.2 Low Voltage Running :

Motor shall be capable of running satisfactorily at seventy five (75) percent nominal voltage for five (5) minutes.

1.13.3 Momentary Low Voltage Withstanding :

Motor, when running at full load, shall not stall when voltage drops down to seventy (70) percent nominal voltage for one (1) minute.

1.14 STARTING CAPABILITY

1.14.1 Low Voltage Starting :

Motor shall be capable of starting and accelerating to full speed at full load (including loaded equipment e.g. mills and conveyors etc) at eighty (80)

percent nominal voltage at motor terminals. Mill motors may be permitted to start with terminal voltage not below 90%.

1.14.2 Cold Motor Starting ..... Under specified voltage variations two (2) starts in quick succession and third start five (5) minutes thereafter, all with full load (including loaded equipment eg mills and conveyors etc) of driven equipment. No additional start will be made till lapse of further thirty (30) minutes.

1.14.3 Hot Motor Starting ..... Under specified voltage variations, one (1) immediate and two (2) fifteen (15) minutes interval starts all with full load (including loaded equipment e.g. mills and conveyors etc) of driven equipment. No additional start will be made till lapse of further thirty (30) minutes.

1.14.4 Motor shall also be suitable for three (3) equally spread starts per hour when the motor is under normal service condition.

1.14.5 Break-away Starting Current .....Breakaway starting current as percent of full load current for various motor ratings shall not exceed the values given below:

1.14.5.1 Motors above 1500 KW upto 4000kW ..... 600% without any positive tolerance except for ID Fan Motor.

1.14.5.2 Motors above 4000 KW ..... 450%. Not subject to any positive tolerance.

1.14.5.3 For D.C. Motors the starting current shall be limited to 2 times full load current.

1.14.5.3 **Starting voltage requirement**

a) All Motors (except Mill Motors)

- 80% of rated voltage for Motors upto 4000 kW
- 75% of rated voltage for Motors above 4000 kW

b) For Mill Motors:

- 85% of rated voltage for Motors above 1000 kW
- 90% of rated voltage for Motors below 1000 kW

Except AOP & JOP motors running on D.G emergency supply, starting voltage shall be 80%.

1.14.5.4 **Starting Time**

1.14.5.4.1 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.

1.14.5.4.2 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.

1.14.5.4.3 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.

1.14.5.5 **Torque Requirements:-**

1.14.5.5.1 Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10%. Motor full load torque.

1.14.5.5.2 Pull out torque at rated voltage shall not be less than 205% of full load torque. It shall be 275% for crane duty Motors.

1.15 **SAFE STALL TIME**

1.15.1 To avoid problem in selecting standard protective relays without using speed switches, safe stall time under hot conditions (corresponding to 110% nominal voltage at motor terminals) shall be more than the accelerating time (corresponding to 80% nominal voltage at motor terminals) by the following minimum values :

1.15.1.01 Two (2) seconds, where accelerating time (at 80% nominal voltage) does not exceed 20 seconds.

1.15.1.02 Three (3) seconds, where accelerating time (at 80% nominal voltage) exceeds 20 seconds.

1.15.1.03 At no stage, speed switch shall be provided to achieve the above requirements mentioned under Clause No. 1.14.5.4

1.16 **CLASS OF INSULATION**

1.16.1 LV Motors ..... Class F.

1.16.2 MV & HV Motors ..... Class F

1.16.03 However temperature rise shall be restricted to limits corresponding to Class 'B' insulation for both HT & LT motors. The temperature under abnormal running conditions shall be limited to 5°C above class 'B' limits.

1.16.04 The value of the polarization index for motors above 200kW should not be less than 2 when determined according to IS: 7816.

1.17 **TEMPERATURE RISE UNDER NORMAL CONDITIONS**..... Temperature rise over specified design ambient temperature when motor is running with full load at nominal supply voltage & frequency shall not exceed the values given below:

S.No.	Specified Design Ambient Temperature	Thermometer Method	Resistance Method
1.17.01	50°C	60°C	70°C
1.17.02	45°C	65°C	75°C
1.17.03	40°C	70°C	80°C

1.18 **BUS TRANSFER WITHSTAND CAPABILITY**

Motors will be connected to an automatic bus transfer system and hence may be subjected to one hundred and fifty (150) percent of the nominal voltage during changeover of buses due to the vector difference between the residual voltage and incoming supply voltage and the duration of this condition may be one second. Motors shall be capable of withstanding the voltage and torque stresses developed under such conditions without damage. The manufacturer/ vendor shall indicate the special precautions taken to meet the above requirements and confirm.

1.18.01 That about 5000 bus transfers, in lifetime of motor, shall not puncture its insulation.

1.18.02 That motor shall be capable of withstanding heavy inrush transient current caused by such bus transfers without damage.

1.18.03 That the motor windings shall be adequately braced to satisfactorily withstand mechanical stresses under these conditions.

1.18.04 The motor and driven equipment shafts shall be adequately sized to satisfactorily withstand transient torques under these conditions.

1.19 **TYPE OF ENCLOSURE**

1.19.01 Outdoor Motors ..... IP 55 (Additional canopy to be provided by EPC contractor.

1.19.02 Indoor Motors ..... IP 55

1.19.03 IP-55 degree of protection shall be achieved without application of any compound, putty etc.

1.19.04 Motor located in hazardous area shall have flameproof enclosure conforming to IS: 2148 /Equiv. as detailed below:

a) Fuel Oil area : Group IIB
b) Hydrogen generation plant area : Group IIC (or Group-I, Div-II as per NEC or Class-1, Gr-B, Div-II as per NEMA/IEC60034).

1.20 **METHOD OF COOLING**

1.20.1 Method of cooling shall be IC 411 (TEFC), IC 511 (TETV) or IC 611 (CACA). However, motors rated 3000kW or above can be closed air circuit water cooled (CACW).

1.20.2 Large capacity motors not available with above types of cooling may be accepted with IC 81 W for IC 91 W (CACW) cooling subject to the approval of the Owner.

1.21 **TYPE OF MOUNTING** ..... As required for the driven equipment.

1.21 **MAXIMUM MECHANICAL VIBRATIONS**

1.21.01 Noise level for all the motors shall be limited to 85dB(A) except for BFP motor for which the maximum limit shall be 90dB(A). Vibration shall be limited within the limits

prescribed in IS: 12075 / 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.

1.21.02 Noise level

The noise level of motors shall not exceed 85 db (A) at 1m from operating motor measured in accordance with IS: 10265.

1.21.03 Motor body shall have two earthing points on opposite sides.

1.21.04 11 KV motors shall be offered with Separate Insulated Connector (Elastimould or Equivalent make) as per IEEE 386. The offered Elastimould terminations shall be provided with protective cover and trifurcating sleeves. Elastimould termination kit shall be suitable for fault level of 25 KA for 0.17 seconds.

1.21.05 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.

1.21.06 The spacing between gland plate & centre of terminal stud shall be as per Table-I.

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.

1.21.07 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.

1.21.08 For motors rated 1500 KW & above, neutral current transformers of PS class shall be provided on each phase in a separate neutral terminal box.

1.21.09 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	:	10.0
(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

1.22 **WINDING & 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 Presure Impregnated i.e resin poor method. Thelightning Impulse& interturn insulation surge withstand level shall be as per IEC-60034 part-15
(d)	240VAC, 415V AC & 220V DC motors	:	Thermal Class(B) or better

1.23 **DIRECTION OF ROTATION**

1.23.1 As needed by driven equipment.

1.23.2 The 3 phase motor shall, however, be suitable for operation in both directions of rotation. A plate showing direction of rotation as determined by the phase sequence on the terminals marking shall be screwed at non-driving end of the body of the motor.

1.23.3 If, in the case of HT motors, fan is suitable for only one direction of rotation, the fan shall be so designed that with the slight modification work, it can be made suitable for other direction of rotation also. No extra material shall be required for doing above modification work.

1.24 **BEARINGS**

1.24.1 General ..... Greased ball, roller and/or sleeve bearing shall be rated for minimum standard life of 20,000 hours taking bearing and driven equipment loads into account. Loss of grease shall be scarce and it shall not creep along shaft into motor housing.

Bearing shall be effectively sealed against dust ingress and shall be pressure grease gun lubricated.

If the bearings are oil lubricated, a drain plug shall be provided for draining residual oil and oil level gauge shall be provided to show precisely oil level required under standstill and running conditions.

Unless otherwise approved, bearing lubricating system shall be such that no external forced oil or water is necessary to maintain required oil supply to keep bearing temperature within design limits.

For MV & HV motors, the bearings shall be insulated wherever necessary to prevent damage to motor bearings from shaft current.

When pressure oiling is required for horizontal motors, bearings shall be sleeve type arranged for pressure oiling supplied from lubrication system of driven machine, with ring oiling for starting and emergency duty. Ring oiling system shall be adequate for starting and continuous operation of motor for at least half an hour, without pressure oiling system in operation. Oil sight flow gauges shall be provided to indicate oil flow through each bearing.

Lubricants shall be selected for prolonged storage and normal use of motors in tropical climate and shall contain corrosion and oxidation inhibitors. Greases shall have suitable bleeding characteristics to minimize setting. The selected lubricants shall be indigenously available.

Sleeve bearings for use with motors having flexible coupling with limited end play, shall have adequate axial end play to prevent transmission of thrust from driven equipment to motor bearings.

Bearings shall be of reputed make subject to the approval of the Owner/Consulting Engineer.

1.24.2 Large motors ..... Large motors shall preferably have spherically seated babitted, ring forced, feed lubricated, water-cooled bearings. If anti-friction bearings are provided, these shall be roller bearings rated for a minimum standard life of 30000 hours taking all bearing and driven equipment loads into account.

1.25 **SHAFT EXTENSION** ..... Key slotted bare shaft extension of required length with key on driving end.

1.26 **DRAIN HOLES** ..... Two (2) drain holes with plugs, one (1) on either end of motor at the bottom most point.

1.27 **LIFTING DEVICES** ..... Motors shall be provided with eyebolts, lugs or other means to facilitate safe lifting.

1.28 **DOWEL PINS**..... It shall be possible to drill holes vertically inclined through motor feet or mounting flange for installing dowel pins after assembling motor and driven equipment, before despatch (for completed driving + driven

equipment assembly) or at site after erection (for separate supplies of above equipment).

1.29 **CENTERING SPIGOT**..... Flange mounted motor shall have centering spigot to match driven equipment socket.

1.30 **EASE OF MAINTENANCE**..... Motor shall be so constructed that it can be de-assembled and reassembled with ease.

1.31 **NAMEPLATES**..... Motor shall have nameplate(s) showing diagram of connections, all particulars as per IS: 325 and following additional information:

In addition, an arrow block shall be screwed on to the body of motor on the non-driving end to indicate direction of rotation of motor.

1.31.1 Temperature rise under normal/abnormal conditions.

1.31.2 Type of bearing and recommended lubricants.

1.32 **FINISH**..... Motor shall have glossy, light grey finish No. 631 as per IS: 5 for withstanding site conditions as per Clause 1.00 above.

All sharp edges and scales shall be removed from the surface, which shall then be thoroughly degreased, de-rusted and given two (2) coats of primer and two (2) coats of finish paint. It is preferred that a phosphate coat is given to motor prior to application of primer coat. Motors for water treatment plant shall have Zinc Chromate base with acid resistant Epilex 4 paint.

1.33 **TERMINAL BOXES**

1.33.1 General .....Motors shall be provided with separate terminal boxes for main, space heaters, embedded temperature detectors, bearing temperature indicators and moisture detectors terminals. When it is not possible to provide LT motors with separate terminal box for space heater terminals, space heater terminals shall be adequately segregated from the main terminals in the single box. Terminal boxes shall be weatherproof and water-tight confirming to minimum IP-55 degree of protection with removable front cover for making connections. IP-55 degree of protection shall be achieved without application of compound. Space between and around terminals shall be adequate for easily connecting aluminium conductor cables. Terminal box arrangement shall be to the approval of the Owner /Consulting Engineer. All terminal boxes shall be suitable for proper termination of the type and tentative size of cables specified in Clause 1.34 below, however, exact size of cables shall be furnished by Owner during engineering stage.

The terminal boxes shall be complete with cable glands and termination accessories as required. Suitable non-magnetic material construction shall be adopted for terminal boxes where single core cables are to be terminated. All HT motors shall be provided with phase segregated terminal box.

Terminal bushings and clamps shall be non-absorbent, non- inflammable, insulated material for connecting with cable.

1.33.2 **Main Terminal Box**

1.33.2.1 LV Motors ..... Main terminal box shall be capable of being turned through 360 degrees in steps of 90 degrees.

1.33.2.2 MV & HV Motors ..... Motor shall be provided with two (2) terminal boxes for stator terminals. One (1) terminal box shall be for phase terminals while other one for forming star connection. These should be interchangeable to facilitate cable routing.

Neutral terminal box for HT motors rated above 1500 KW shall be suitable for mounting of three (3) Nos. wound/bar primary/ring type cast resin insulated current transformers for differential protection. These transformers shall be supplied and mounted in the motor terminal box. In addition to above, 3 Nos. of identical current transformers shall be supplied loose for mounting in the switchgear. Stator phase terminal box may either be phase segregated of standard terminal box suitable for both top and bottom entry of cables (i.e. they should be capable of being turned through 180 Degrees). The terminal box shall be designed for termination of XLPE cables using heat shrinkable or push on type terminating Kit. Terminal leading shall be stud type or leading wire type.

1.33.2.3 Cable End Boxes.....Terminal Boxes shall be provided with cable end boxes having cable lugs and cable glands for cables of sizes as specified in Clause 1.34 below.

Cable box shall be suitable for glanding the cables; and shall have adequate space between cable glands terminating studs to allow suitable bends of cable inside the cable box for all 3 phases of relevant cable sizes specified.

1.33.2.4 The terminal boxes shall be capable of withstanding at the terminals the system fault level (as indicated below) without rupture for a duration of atleast 0.25 seconds.

Min. fault level for MV Motors - 40 KA

Min. fault level for LV & HV Motors - 50 KA

1.33.2.5 **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

1.33.2.6 Terminal Accessories.....Each terminal end shall be furnished with bimetallic washers, spring washers, nuts and crimp type aluminium (preferably tinned) lugs suitable for cables of sizes as specified in Clause 1.34 below.

1.34 **TYPE AND SIZE OF CABLES**

1.34.1 **Space Heaters**

1.34.1.1 For LV Motors: Two point five (2.5) mm^2, two (2) core copper conductor PVC insulated, armoured and FRLS PVC sheathed heavy duty 650/1100 V grade cable to IS: 1554 (Part-I).

1.34.1.2 For MV & HV Motors: Six (6) mm^2 two core aluminium conductor PVC insulated armoured and FRLS PVC sheathed heavy duty 650/1100V grade cable to IS: 1554 (Part-I).

1.34.2 For Embedded Temperature Detectors two sets of six (6) Twisted triad 0.5 mm^2 ATC copper conductor armoured, shielded cable, 650/1100 V Grade IS: 1554 (Part-I). For bearing temperature, RTDS, two (2) sets of four (4) twisted triad 0.5 mm^2, ATC copper conductor armoured shielded 650/1100 V Grade, IS: 1554 (Part-I).

1.34.3 Bearing Temperature Indicators - For each indicator, 0.5 mm^2 six (6) tarnished triad ATC copper conductor, PVC insulated, shielded armoured and FRLS PVC sheathed heavy duty 650/1100 V grade cable as per IS: 1554 Part-I. Two (2) cables one (1) for each bearing temperature indicator.

1.34.4 For Moisture Detectors.....As for space heaters as per Clause 33.01.01 above.

1.34.5 **For Main Terminals**

LT Motors

1. Three (3) core cables ……Stranded aluminium conductor, XLPE insulated, colour coded, laid up, PVC sheathed, GI wire / strip armoured, FRLS PVC jacketed overall, 650 / 1100V grade, heavy-duty cables as per IS: 1554 (Part-I).

2. Single core cables ……Stranded aluminium conductor, XLPE insulated, hard drawn aluminium wire/ strip armoured FRLS PVC jacketed overall, 650 / 1100V grade, heavy duty cable as per IS: 1554 (Part-I).

HT Motors

1. Three (3) core cables …… stranded aluminium conductor, XLPE insulated, screened colour coded, laid up, PVC sheathed, GI wire/strip armoured FRLS PVC jacketed overall, 6.6 KV / 11 KV grade, heavy duty cables as per requirement for unearthed system as per IS: 7098 (Part-II).

The size and no. of cable to be intimated to the successful bidder during detailed engineering and the contrcator shall provide terminal box, cable gland and lugs suitable for the same.

Cable size may be increased in some cases because of large number of cables in under-ground ducts or because of vaoltage drop consideration. The supplier shall supply with terminal box and cable accessories suitable for higher size of cable at no extra cost.

1.35 **EARTHING**

1.35.01 General..... Two (2) grounding terminals one (1) on either side at the bottom suitable for connecting mild steel/GI flat/GI wire grounding conductor, size of grounding conductor shall be decided during detailed engineering.

1.35.02 LV Motors.....At each earthing point, two (2) drilled and tapped holes with hexagonal head bolts, plain washers, spring washers and tinned lugs (for motors upto 5.5 KW) for size of conductor specified shall be provided.

1.35.03 MV & HV Motors.....Non-corrodible metallic grounding pad shall be welded or brazed at each earthing point. The size of grounding pad shall be 75x65x25 mm. Grounding pad shall have 40 mm apart two (2) drilled and tapped holes with hexagonal head bolts, plain washers and spring washers for size of conductor specified. In addition, one suitable earthing terminal shall be provided inside the stator phase terminal box for earthing metallic shield of XLPE cables.

1.36 **EMBEDDED TEMPERATURE DETECTORS**.....HT motor shall be provided with six (6) Nos. duplex resistance temperature detectors (RTDs) embedded in stator winding at locations where high temperatures are expected. In addition one (1) duplex type RTD shall be provided in each bearing. The RTDs shall be 3 wire duplex platinum resistance type having a value of 100 ohms at 0 Deg.C

1.37 **BEARINGS TEMPERATURE INDICATORS**..... HT motors shall be provided with dial type two (2) bearing temperature indicators and will have two (2) sets of contacts, each set having 2 NO + 2 NC contacts rated for 5A at 240V AC and 0.5A at 220V DC. One set will be set to operate at lower value to give alarm and other set at a higher value to trip the motor.

1.38 **SPACE HEATERS**.....Valve / Damper actuator motors; and Motors above 30 KW shall be provided with one (1) or two (2) space heaters suitable for 240V, 50 Hertz single phase AC supply and of adequate capacity to maintain motor internal temperature above dew point to prevent moisture condensation or deterioration of insulation during shut down. Heaters shall be mounted inside the motor in accessible locations so that their removal and replacement is simple. Motors upto 30 kW shall have stator windings suitable for connections to 24V, 50 Hz AC supply for space heating.

Motors upto 30 kW shall have stator windings suitable for connection to 24V, 50 Hz ac supply for space heating

The terminals of space heaters shall be brought out to a separate totally enclosed dust proof and weatherproof terminal box.

1.39 **HOT AIR TEMPERATURE DETECTOR**

If the motor is of CACA or CACW enclosure, a thermometer with alarm contracts in hot air circuit shall be provided.

1.40 **WATER FLOW INDICATOR**

If the motor is of CACW enclosure a provision shall be made for visual indication of water flow and flow switch shall also be provided with alarm contacts. Thermometers shall be provided in water inlet and outlet circuits.

1.41 **MOISTURE DETECTORS**.....Motors with type of cooling 1C 81W or 1C 91 W shall be provided with moisture detectors for raising alarm in the event of water tube failure.

1.42 **BED PLATE**.....Whenever motor is supplied with driven equipment the Supplier shall ensure that bed plate suits both motor and driven equipment and is adequately braced to keep vibration and misalignment within allowable limits to the approval of driven equipment and motor manufacturers.

1.43 **OTHER ACCESSORIES**..... Motor shall be supplied with all accessories and parts other than those, specified above which are necessary and/or useful for efficient operation.

1.44 **TYPE TEST**

1.44.01 **HT MOTORS**

a) 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. The type tests charges shall be paid only for the test(s) actually conducted successfully under this contract.

b) The type tests shall be carried out in presence of the Purchaser's representative, for which minimum 15 days notice shall be given by the contractor. The contractor shall obtain the Purchaser'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.

c) In case the contractor has conducted such specified type test(s) within last five years as on the date of bid opening, he may submit during detailed engineering the type test reports to the Purchaser's 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 Purchaser's 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.

d) 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 five 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 five 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 Purchaser's either at third party lab or in presence of client representative and submit the reports for approval.

e) **LIST OF TYPE TESTS TO BE CONDUCTED**

The following type tests shall be conducted on each type and rating of HT motor

i) No load saturation and loss curves upto approximately 115% of rated voltage

ii) Measurement of noise at no load.

iii) Momentary excess torque test (subject to test bed constraint).

iv) Full load test(subject to test bed constraint)

v) 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.

f) **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

i) Degree of protection test for the enclosure followed by IR, HV and no load run test.

ii) Terminal box-fault level withstand test for each type of terminal box of HT motors only.

iii) Lightning Impulse withstand test on the sample coil shall be as per clause no. 4.3 IEC-60034, part-15

iv) Surge-withstand test on interturn insulation shall be as per clause no. 4.2 of IEC 60034, part-15

1.44.02 **LT Motors**

a) LT Motors supplied shall be of type tested design. During detailed engineering, the contractor shall submit for Purchaser's approval the reports of all the type tests as listed in this specification and carried out within last five 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.

b) However if the contractor is not able to submit report of the type test(s) conducted within last five 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 Purchaser's shall conduct all such tests under this contract at no additional cost to the Purchaser either at third party lab or in presence of client representative and submit the reports for approval.

1.44.03 **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

i) Measurement of resistance of windings of stator and wound rotor.
ii) No load test at rated voltage to determine input current power and speed.
iii) Open circuit voltage ratio of wound rotor motors (in case of Slip ring motors)
iv) Full load test to determine efficiency power factor and slip .
v) Temperature rise test.
vi) Momentary excess torque test.
vii) High voltage test.
viii) Test for vibration severity of motor.
ix) Test for noise levels of motor(Shall be limited as per clause no 1.21.01 of this section)
x) Test for degree of protection and
xi) Over speed test.
xii) Type test reports for motors located in fuel oil area having flame proof enclosures as per IS 2148 / IEC 60079-1

1.44.04 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.

1.45 **INFORMATION WITH PROPOSAL**

1.45.1 AC Motor Data Sheet.

1.45.2 Dimension Drawing/Foundation load details of motor and driven equipment.
1.45.03 Manufacturer's catalogue showing constructional details.

1.46.00 **INFORMATION ON AWARD OF CONTRACT**.....Within six (6) weeks from the date of award of the Contract, following shall be furnished:

1.46.01 Motor Data Sheet.

1.46.02 Certified binding dimension drawing of motor complete with all accessories and fittings specifically showing terminal boxes, terminal spacing and sizes, earthing connections and sizes thereof, mounting details, lifting lugs, final foundation loads and dimensions with tolerances of centering spigot (where needed), shaft extension and key.

1.46.03 Following characteristics curves:

1.46.03.01 Torque-speed curves for motor at eighty (80), hundred (100) and hundred ten (110) percent rated voltage as well as torque-speed curve for driven equipment.

1.46.03.02 Current-speed curves at eight (80), hundred (100) and hundred ten (110) percent rated voltage

1.46.03.03 Current-time curves at eighty (80), hundred (100) and hundred ten (110) percent rated voltage.

1.46.03.04 Thermal withstand curves for hot and cold at eighty (80), hundred (100) and hundred ten (110) percent rated voltage.

1.46.03.05 Efficiency, power factor, current and speed versus power output curves.

1.46.03.06 Speed-time curves at eight (80), hundred (100) and hundred ten (110) percent rated voltage.

1.46.03.07 Negative phase sequence current withstand characteristics.

1.47 COMMISIONING CHECK LIST (HT MOTORS)

A PRELIMINARY CHECKS

Check the following:

1. Check the name plate details according to specification. Discrepancies, if any, to be satisfactorily resolved.

2. Check tightness of all bolts, clamps and connecting terminals.

3. Check body earthing

4. Check whether bearing lubrication is adequate

5. Check clearance inside terminal box

6. Checking stator (motor air gap) Check – Grease lubrication (for ball or roller bearing) is adequate if the motor was in storage for very long period replace the grease, by fresh grease after flushing the bearing clean. Excess grease in the bearing (housing … is overheat of bearings) Check 0 the free rotation of the rotor in decoupled condition. Check the air gap between stator and rotor at four positions 90o apart at driving and non-driving end. Compare the recorded values with factory results. For slip ring motors : with starting resistances.

   a) Check the variation of resistance
   b) Check brush lifting and slip ring short.

B COMMISSIONING CHECKS

1. Meggar tests of motor winding and cables
2. Continuity check of motor windings control and power cables
3. Measure resistance of motor winding (in case of large motors)
4. Control and interlocks should be checked
5. Motor protection relay to be calibrated
6. Phase sequence and direction of rotation
7. Other than DOL scheme to be checked example trafo starts
9. Measure starting current starting timer and no load current
10. On load operations starting and running currents (observed vibrations, temperatures of bearings and body)
11. On load operation, starting and running currents (observed vibrations, temperatures of bearings and body)
12. In case of forced water cooling of start or check winding temperatures as ready by built in RTDs.
13. Water level (start up cooling) low to be checked for limit switch operation.

1.48 COMMISIONING CHECK LIST (LT MOTORS)

A PRELIMINARY CHECKS

Check the following:

1. Check the name plate details according to specification. Discrepancies, if any, to be satisfactorily resolved.
2. Check tightness of all bolts, clamps and connecting terminals.
3. Check body earthing
4. Check whether bearing lubrication is adequate
5. Check clearance inside terminal box

B COMMISSIONING CHECKS

1. Meggar tests of motor winding and cables
2. Continuity check of motor windings control and power cables
3. Over load and short circuit relay tests and settings
4. Control and interlocks should be checked
5. Phase sequence and direction of rotation
6. Operation of timer in case of star delta starting
7. Measure starting current starting timer and no load current
8. On load operations starting and running currents

1.49 DC MOTOR SPECIFICATION

DC Motor will be of continuous duty type totally enclosed fan cooled (TEFC) having IP-54 degree of protection suitable for 220 V DC supply. DC motor will be shunt wound type having high torque characteristic suitable for Bi-directional rotation at rated speed and output. The general constructional features and details of DC motor will be in line with details/ particulars stipulated in the specification for AC squirrel cage induction motors.

Contractor will furnish the data in respect of DC motors.

DATASHEET

	Auxiliary power supply	
1.1	**HV supply**	
	11kV, 3Φ, 3W, 50 Hz non effectively earthed	Motors rated above 1500 kW
	Fault level	50 kA for 1 second
1.2	**MV supply**	
	3.3kV, 3Φ, 3W, 50 Hz non effectively earthed	Motors above 200kW upto and including 1500kW
	Fault level	40 kA for 1 second
1.3	**LV supply**	
	415V, 3Φ, 3W, 50 Hz effectively earthed	Motors below and including 200kW
	Fault level	50kA for 1 second
	110V, 1Φ, 2W, 50 Hz effectively earthed	Lighting, space heating, AC control and protective devices
1.4	**DC supply**	
	220V,2W, unearthed	DC alarm, control and protective devices.
	Fault level	25 kA for 1 second
2	Range of variation	As indicated in the specification
2.1	AC supply	
	voltage	------
	Frequency	------
	Combined voltage & frequency	--------
2.2	DC supply	198 to 240 V
Note: During starting of largest motor, the voltage may drop to 80% of the rated voltage for a period of 60 seconds. All electrical equipment while running shall successfully ride over such period without affecting system performance.		

CHAPTER 26 : CABLING SYSTEM

1.00.00 SCOPE OF WORK

The scope of work covers supply, erection, testing and commissioning of complete electrical system including cabling,fire stop mortar seal, fire retardant cable coating system etc. the scope shall broadly cover, but not be limited to:

(a) Main power house building.

(b) Boiler area, ESP.

(c) Transformer yard.

(d) All auxiliary buildings (including electrical rooms of respective buildings) and structures as per details in the General electrical specification/ plot plan/ &related drawings.

(e) Coal handling plant.

(f) Ash handling plant including ash dyke

(g) Raw water system

(h) Fuel oil unloading & transfer system.

(i) Aux. power transformers

(j) Pipe cum cable rack.

(k) All electrical equipment as described in different sections.

(l) As built drawing for all above systems on completion of project.

The scope of work shall also include all civil and structural works necessary for successful installation, commissioning & commercial operation of all electrical equipment to be erected under this specification.

2.00.00 SCOPE OF SUPPLY

2.01.00 The equipments and materials within the scope of supply shall include but not limited to :-

i. Power & control cabling works (including that of special cables):

ii. Galvanized steel pre-fabricated cable trays, coupler plates, nuts, bolts & washers, reducers, covers, wall brackets, hanger clamps, straight run, elbows, bends, cable trays supporting structures etc.

iii. Supply and installation (including laying & termination) of control cables, special cables, instrumentation cables for all equipments and systems.

iv. Supply and installation (including laying & termination) of all power cables (HV and LV) of all power cables (HV and LV) for all equipments and systems.

v. Cable routing has to be planned such that it shall not cross the steam lines, oil lines.

vi. Fire Sealing Arrangement: All cable entries into the panel (HV & MV & LV SWGR panels) should be provided with fire sealing arrangements.

vii. Cable/cable tray openings in walls and floors or through pipe sleeves from one area to another or from one elevation to another within the unit shall be seated by a fire proof sealing system (FPSS). The FPSS shall effectively prevent the spread of fire from the flaming to non-flaming side of a fire.

viii. Galvanized steel rigid/ flexible conduits and accessories, ferrules, lugs, glands, terminal blocks, galvanized sheet steel junction boxes, cable fixing clamps, nuts & bolts etc as required.

ix. All necessary erection materials, consumables and sundry items including arc welding rods to complete the installation for satisfactory and trouble free operation.

x. Any item of works or erection materials which have not been specifically mentioned but are necessary to complete the work involved shall be deemed to be included in the scope of this specification and shall be furnished by the contractor without any extra charge to the purchaser.

3.00.00 CODES AND STANDARDS

All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS codes, standards, etc.) referred to herein, the former shall prevail. All work shall be carried out as per the following standards/ codes as applicable.

IS:513	Cold rolled low carbon steel sheets and strips.
IS:1079	Hot Rolled carbon steel sheet & strips
IS:1239	Mild steel tubes, tubular and other wrought steel fittings
IS:1255	Code of practice for installation and maintenance of power cables upto and including 33 KV rating
IS:1367 Part-13	Technical supply conditions for threaded Steel fasteners. (Hot dip galvanized coatings on threaded fasteners).
IS:2147	Degree of protection provided by enclosures for low voltage switchgear and control gear
IS:9537	Conduits for electrical installation.
IS:9595	Metal – arc welding of carbon and carbon manganese steels - recommendations.
IS:13573	Joints and terminations for polymeric cables for working voltages from 3.3kv up to and including 33kv performance requirements and type tests.
IS:802	Code of practice for the use of Structural Steel in Overhead Transmission Line Towers.

IS:2309	Code o practice for the protection of building and allied structures against lighting.
IS:2629	Recommended practice for hot dip galvanising of iron & steel.
IS:2633	Method for testing uniformity of coating on zinc coated articles.
IS:6745	Method for determination of mass of zinc-coating on zinc coated iron & steel articles.
IS:9308	Compression type tubular in-line connectors for aluminium conductors of insulated class.
IS:8309	Compression type tubular terminal ends for aluminium conductors of inslated cables.
BS:476	Fire tests on building materials and structures
DIN 46267 (Part-II)	Non tension proof compression joints for Aluminium conductors.
DIN 46329	Cable lugs for compression connections, ring type ,for Aluminium conductors
VDE 0278	Tests on cable terminations and straight through joints
BS:6121	Specification for mechanical Cable glands for elastomers and plastic insulated cables.
	Indian Electricity Act.
	Indian Electricity Rules.

Equipment complying with other internationally accepted standards such as IEC, BS, DIN, USA, VDE etc. will also be considered if they ensure performance and constructional features equivalent or superior to standards listed above. In such a case, the Contractor shall clearly indicate the standard(s) adopted, furnish a copy in English of the latest revision of the standards along with copies of all official amendments and revisions in force as on date of opening of bid and shall clearly bring out the salient features for comparison.

4.00.00 DESIGN AND CONSTRUCTIONAL FEATURES

4.00.01 Inter Plant Cabling

4.01.00

Interplant cable routing will be on overhead cable trays on pipe cum cable trestle or only cable trestle except where approved by purchaser/consultant.

Major routes in boiler area to individual boiler drives, fly ash conveying compressor building, ESP building, CW pump house, Raw water pump house, DM plant, Filter water pump house, Clarified water pump house, Fly ash silo fluidizing blower house etc will be on overhead Cable trays either supported from available structures or on pipe cum cable trestle or on only cable trestle. Only in specific areas as will be approved by purchaser/consultant where number of cables are too small compared to the route length like Intake pump house & Ash dyke, cables may be directly buried underground with marker.

Overhead trestle will be provided to the extent possible. Cable routes shall be provided in such a manner that movement of crane does not get restricted and also the cables are to be routed at a safe distance from hot pipes. Generally the bottom of steel supporting structure shall be at 6.5m above the grade level. Where rail/road crossing is involved the same shall be minimum at 8m above the grade level.

Individual shallow trench shall be routed from switchyard equipment to main switchyard trench which will be routed up to Switchyard control room. Interconnecting cables from Power House to Switchyard control room shall be routed through RCC trenches. From trenches to the switchyard equipments, all power and control cables shall be laid through PVC conduit.

Space for accommodating additional trays, which may come in future shall be provided in present cable route. Some trays may be required for use by the purchaser, which will be finalized during detail engineering stage. The successful bidder shall provide such trays without any extra cost to purchaser.

For Power supply to Raw Water Intake Pump house, Cable from powerhouse will run on overhead Cable trays up to Plant boundary. After that it will be buried cable that will follow the intake pipeline corridor.

For Power supply from Power House to Main CHP Substation Building and from Main CHP Substation Building to Crusher House & Pump House, Cable will run on overhead Cable trestles. Further, Cable shall be routed through the conveyor gallery / TPs / Crusher House by separate supporting structures and trench in the pump house.

4.02.00 Trenches

4.02.01 PCC flooring of built up trenches shall be sloped for effective drainage with sump pits and sump pumps.

4.02.02

4.02.03 All field switches for equipments corresponding to a stream located within a radius of 4-5 m shall be wired out to a field junction box and from field junction box to control panel/Input – Output cabinet by screened instrumentation cables.

4.02.04 For CHP following shall also be applicable:

a) All cable routes shall be overhead along the route of the conveyor gallery by separate supporting structures and cables shall be laid in vertical trays. The bottom of the steel shall be such that the existing facilities, movement of trucks/human beings etc. does not get affected. The cable trestle shall have a minimum 600 mm clear walk way and shall have maintenance platforms as required. The bottom of the steel supporting structure shall be generally at 6.5 M above the grade level except for rail/road crossings where it shall be at 8.0 M above grade level. However in bunker area the bottom of the cable trestle shall be 10 to 14 M depending on boiler/bunker layout.

b) Cable trenches shall be provided only in Switchgear/MCC rooms.

c) Cables shall not be routed through the conveyor galleries except for the equipment located in the conveyor galleries for a particular conveyor i.e. protection switches, receptacles etc.

d) Cables for Pull cord switches and belt sway switches shall be taken in cable trays. The trailing cables of the mobile machines shall also be laid in cable trays.

e) Two separate cable routes one on each side shall be provided for each boiler unit.cables for one set of auxiliaries such as ID,FD & PA fans & half of the coal mils shall be routed in one route & for through other set of auxiliaries through other route.

Cable trays in Boiler & ESP area shall be supported from the Boiler & ESP structure.The same shal be co-ordinated wih SG/ESP contractors

Cable trays in these areas shall be in vertical formation to avoid dust accumulation. No cable trenches shall be provided in Boiler/ESP area.

Contractor shall provide two independent routes for cables between ESP control room & ESP. Contractor shall provide the cable trays along with its supporting structure arrangement on the trestle.

f) **Turbine Hall Area:**

Two separate cable routes shall be provided for cable routing of working & standby drives or different sets/groups say 50% capacity) of auxiliaries.

g) **OffSite Area:**

In offsite area pumphouses, overhead cable tray arrangement shall be perferably followed.

h) **Cable Vault:**

Cable gallery (over ground) to be provided below each electrical control/switchgear room .

Cable vault of not less than 3 mts clear height from bottom of beam shall be provided.

Clear access passage of at least 750 mm wide & 2.0 Mts clear height shall be provided at entrances & along cable ways.Wherever the passage is through cable routes clear height shall not be less than 1.5 Mts.

Cable vaults shall be provided with adequate drainage facility for drainage of fire water.

Each cable vault should have two doors.

Exit signs shall be provided near doors for personnel escape in case of emergency.

5.00.00 EQUIPMENT DESCRIPTION

5.01.00 Cable trays, Fittings & Accessories

5.01.01 Cable trays shall be ladder/perforated type as specified complete with matching fittings (like brackets, elbows, bends, reducers, tees, crosses, etc.), accessories (like side coupler plates, etc.) and hardware (like bolts, nuts,

washers, G.I. strap, hook etc.) as required. Cable tray shall be ladder type for power & control cables and perforated for instrumentation cables.

5.01.02 These shall be either prefabricated hot dip galvanized sheet steel trays or site fabricated angle iron trays free from flaws such as laminations, rolling marks, pitting etc. These (including hardware) shall be hot dip galvanized as per relevant IS.

5.01.03 Cable trays shall have standard width of 600 mm, however trays with 450mm, 300mm and 150mm may be used in places considering the requirement and space constraint. and standard lengths of 2.5 metre. Minimum thickness of mild steel sheets used for fabrication of cable trays and fittings shall be 2 mm. The thickness of side coupler plates shall be minimum 3 mm.

5.01.04 Cable troughs shall be required for branching out few cables from main cable route. These shall be U-shaped, fabricated of mild steel sheets of minimum thickness 2 mm and shall be hot dip galvanized as per relevant IS. Troughs shall be standard width of 50 mm & 75 mm with depth of 25 mm.

5.01.05 Prefabricated hot dip galvanized sheet steel cable trays shall be used for maximum support span of maximum 1.25M for horizontally and 1.0M for vertically unless design is approved for larger span. Cable trays shall be suitable for a cable weight of 100 kg/meter running length of tray. Minimum thickness of sheet steel/galvanizing shall be 2mm/86 microns respectively. The amount of zinc deposit shall not be less than 610 gm per square meter.

In areas, where acid/alkalie ingration is likely to occur, glass reinforced plstic trays with fire retardant corrosion resistance properties shall be used.

5.01.06 Cable trays fabricated from standard rolled sections shall be 50x50x6/75x75x6 sections for runners for supporting spans limited to 2000 mm/more than 2000 mm respectively. Cross support shall be 32x6 mm / 50x6 flat for widths up to 500mm/more than 500mm respectively.

5.01.07 Separate coloured paint strips shall be applied for identification of different type of trays depending upon types of usage/applications/area as below:

High/ medium voltage cables: red strips, 2 inch width each, numbers
11kv/3.3kv equally spaced at 5 metres interval
1.1kv power cables : yellow strips ------- do -------
1.1kv control cables : blue strips ------- do -------
Instrumentation cables : green strips ------- do -------

5.02.00 Support System for Cable Trays

5.02.01 Cable tray support system shall be pre-fabricated similar or equivalent to "Unistrut make".

5.02.02 Support system for cable trays shall essentially comprise of the two components i.e. main support channel and cantilever arms. The main support channel shall be of two types: (i) C1:- having provision of supporting cable trays on one side and (ii) C2:-having provision of supporting cable trays on both sides. The support system shall be the type described hereunder:

a. Cable supporting steel work for cable racks/cables shall comprise of various channel sections, cantilever arms, various brackets, clamps, floor

plates, all hardware such as lock washers, hexagon nuts, hexagon head bolt, support hooks, stud nuts, hexagon head screw, channel nut, channel nut with springs, fixing studs, etc.

b. The system shall be designed such that it allows easy assembly at site by using bolting. All cable supporting steel work, hardware's fittings and accessories shall be prefabricated factory galvanised.

c. The main support and cantilever arms shall be fixed at site using necessary brackets, clamps, fittings, bolts, nuts and other hardware etc. to form various arrangements required to support the cable trays. Welding of the components shall not be allowed. However, welding of the bracket (to which the main support channel is bolted) to the overhead beams, structural steel, insert plates or reinforcement bars will be permitted. Any cutting or welding of the galvanized surface shall be brushed and red lead primer, oil primer & aluminium paint shall be applied.

d. All steel components, accessories, fittings and hardware shall be hot dip galvanized after completing welding, cutting, drilling and other machining operation.

e. The main support channel and cantilever arms shall be fabricated out of minimum 2.5 thick rolled steel sheets conforming to IS.

f. Cantilever arms of 300 mm, 600 mm and 750 mm in length are required. The arm portion shall be suitable for assembling the complete arm assembly on to component constructed of standard channel section. The back plate shall allow sufficient clearance for fixing bolt to be tightened with tray in position.

g. Cable trays in areas subjected to excessive coal dust or mechanical damage shall have hot dip galvanized sheet steel metal trays cover installed on front tray in vertical run and inverted 'V' type on upper tray in horizontal run with consideration for ventilation.

5.02.03 The size of structural steel members or thickness of sheet steel of main support channel and cantilever arms and other accessories as indicated above are indicative only. Nevertheless, the support system shall be designed by the contractor to fully meet the requirements of type tests as specified. In case the system fails in the tests, the components design modification shall be done by the Contractor without any additional cost. The contractor shall submit the detailed drawings of the system offered by him along with the bid.

5.03.00 Pipes, Fittings & Accessories

5.03.01 Pipes offered shall be complete with fittings and accessories (like tees, elbows, bends, check nuts, bushings, reducers, enlargers, coupling caps, nipples etc.) The size of the pipe shall be selected on the basis of maximum 40% fill criteria

5.03.02 GI Pipes shall be of medium duty as per IS: 1239.

5.03.03 The contractor shall provide and install all conduits, mild steel pipes, flexible conduits, rigid PVC pipes, etc. complete with accessories like tees, bends, adopters, locknuts, pull boxes, conduit plugs, caps, etc as required for the cabling work. Conduits shall be furnished in standard length of 5 metres, threaded at both ends.

5.03.04 Conduits diameter upto and including 25mm size shall be of 16 SWG and conduits above 25 mm diameter shall be of 14 SWG. Minimum diameter of conduits shall be 20 mm.

5.03.05 Conduits shall be made of hot-dip galvanized steel with an organic corrosion resistant ID coating. In chemical handling areas, battery room, etc., the exterior surface shall be further coated with chromate and polymer for better resistance to corrosion. Conduits, fittings & accessories shall have ISI mark.

5.03.06 For sizes above 63 mm, hot dip galvanized - both on inside and outside - steel pipes with necessary fittings & accessories shall be provided and installed by the contractor. The pipes and fittings shall be of heavy duty class with relevant ISI mark.

5.03.07 Flexible conduits complying to relevant IS and made with bright, cold_rolled, annealed and electro_galvanized mild steel strips shall be used between embedded conduits/pipes and the motor terminals. It shall also be used between fixed conduit and any equipment with vibration or equipment requiring regular removal.

5.03.08 Duct banks shall be High Density PE pipes encased in PCC (10% spare of each size, subject to minimum one) with suitable water-proof manholes.

5.04.00 Junction Boxes

5.04.01 Junction Boxes shall comprise of a case with hinged door constructed from cold rolled sheet steel of minimum thickness 2mm. Top of the boxes shall be arranged to slope towards rear of the box. Gland plate shall be 3 mm thick sheet steel with neoprene/synthetic rubber gaskets. All junction boxes shall be of adequate strength and rigidity, hot dip galvanised as per relevant IS, and suitable for mounting on wall, columns, structures etc. The boxes shall include brackets, bolts, nuts, screws M8 earthing stud etc. required for installation.

5.04.02 **Glass Fibre Reinforced Junction Boxes (for outdoor use)**

No. of Ways: 12/24/36/48 with 20% spares terminals.

5.04.03 Junction boxes shall be Glass Fibre Reinforced with saturated polyester conforming to standards like DIN 16911 type 803/16913 type 834, 5 self extinguishing in accordance with ASTM D635/UL 94 VO.

Junction boxes for use in outdoor or damp locations shall be sturdy construction. Temperature resistance shall be between – 10 to 100^{o}C. Impact resistance shall be greater than 7 Nm, (EN 50014). Protective insulation shall be in line with VDE 0100, dielectric strength shall be greater than 10 KV/mm, halogen free toxicity, the enclosure and door cover shall be painted and electro statically power coated (preferably in RAL 7032). Earth connection (studs size shall be M 6) shall be provided on the cover as well as door.

5.04.04 Doors

With integrated viewing window of 3mm resistant plexi glass or equivalent. The doors shall be industrial heavy duty hinges. The doors shall be easily but firmly lockable with quick release fastener.

5.04.05 Protection Class

Protection Category shall be IP 66 to EN 60529. There shall be guaranteed perfect seal to meet Protection class IP 66 providing arrangement like highly elastic foamed in special type seal like polyurethane/chloroprene. The sealing

rubber shall not have aging effect and shall retain its sealing characteristics for more than 20 years. Contractor shall indicate this in data sheet. The rubber seal should be pasted at its place with pasting technology for like more than 20 years (double sealing arrangement is preferred).

5.04.06 **Mounting clamps and accessories**

Junction boxes shall be suitable for mounting on walls, columns and structure. Brackets, bolts, nuts, screws, glands and lugs required for erection shall be of brass. The accessories like mounting plates etc. of steel shall be powder coated. The support rails for terminal box shall be zinc coated.

5.04.07 General

- JBs shall have small canopy at the top.
- There shall be rainwater collection arrangement from top and side of the outer ages to ensure that any leakage into the junction box shall be avoided and it shall fall outside.
- Cable entry shall be from bottom side only.
- Ensure gland plate sealing perfect. It shall be of the same quality and arrangement as that of door to cover arrangement.

5.04.08 **Steel Junction Boxes (for indoor use)**

5.04.09 No. of Ways

12/24/36/48 with 20% spares terminals.

5.04.10 Junction boxes shall be designed in accordance with NEC, article 370, paragraph 18,19 & 20 or equivalent standards.

5.04.11 Enclosure

Junction boxes for use in outdoor or damp locations shall be sturdy steel construction. The enclosure and door cover shall be surface finished clean, degreased, phosphated, deep coated primed (preferably in RAL 7044) and electro-statically powder coated (preferably in RAL 7032). Earth connection (studs size shall be M6) shall be provided on the cover as well as door. The sheath steel thickness shall be more than 2 mm.

5.04.12 Doors

The doors shall be hinged and lockable. The doors shall have industrial heavy duty hinges. The doors shall be easily but firmly lockable with quick release fastener.

5.04.13 Protection Class

Protection Category shall be IP 66 to EN60529/1091 complies with NEMA 4. There shall be guaranteed perfect seal to meet Protection class IP 66 providing sealing arrangement like highly elastic foamed in special type seal like polyurethane. There shall be an arrangement like multifold protection channel for additional stability and prevention of ingress of dust and water when the enclosure is open.

The sealing rubber shall not have aging effect and shall retain its sealing characteristics for more than 20 years. Contractor shall indicate this in data

sheet. The rubber seal should be pasted at its place with pasting technology for like more than 20 years (double sealing arrangement is preferred).

5.04.14 Mounting clamps and accessories

The mounting clamps and accessories shall be suitable for mounting on walls, columns and structure. Brackets, bolts, nuts, screws, glands and lugs required for erection shall be of brass.

5.04.15 General

- JBs shall have small canopy at the top.
- There shall be rainwater collection arrangement from top and side of the outer ages to ensure that any leakage in to the junction box shall be avoided and it shall fall outside.
- Cable entry shall be from bottom side only.
- Ensure gland plate sealing perfect. It shall be of the same quality and arrangement as that of door to cover arrangement.

5.04.16 Junction boxes shall be provided with two nos. earthing terminals (externally available) suitable for connection of 8 SWG G.I. wire. Knockouts shall be provided at bottom and both sides. These shall be provided by fixing plates in order to make them detachable type with suitable neoprene gaskets. Bottom and side plates for cable/conduit connection shall be provided. All unused holes shall be sealed with suitable grommets.

5.04.17 Junction boxes shall be provided with external designation label. The label inscriptions shall be informed to the Contractor by the Owner. Junction boxes shall be provided with danger sign in case of 415V circuit.

5.04.18 Junction boxes shall be of two types, viz. One suitable for control cabling and the other suitable for power cabling.

Junction boxes for control cabling shall have 24 way/ 48 way terminal blocks suitable for up to 2.5 sq.mm. Cu. Cable. However, for instrumentation junction boxes there shall be 24/48 ways suitable for terminating cable of 0.5 sq.mm. Cu. Cable.

5.04.19 Junction boxes for power circuit cabling shall be suitable for 1 no. 3 core 16 sq.mm. Al. Incoming cable and 1 no. 3 core 2.5 sq.mm Cu. Outgoing cable.

5.05.00 Terminal blocks

Terminal blocks shall be 650 volts grade, rated for 10 Amps and in one piece, rigid, Bakelite moulded, with disconnecting /shorting link. It shall be complete with insulating barriers, Klip-on-type terminals and identification strips, terminal studs, washers, nuts, look nuts, marking strips etc.
Marking on terminal strip shall correspond to the terminal numbering on wiring diagrams. It shall be Elmex type CSLT-1 with insulating material of Melamine conforming to ESI Standard 12.1 or equivalent. Cage clamp type terminal block suitable for terminating 2 wires of 2.5 sq mm. on both sides arranged to facilitate easy termination shall be provided.

5.06.00 Terminations & Straight through Joints

5.06.01 Termination and jointing kits for 11/3.3 kV grade XLPE insulated cables shall be of proven design and make which have already been extensively used and type tested. Termination kits and jointing kits shall be pre-moulded type, taped type or heat shrinkable type. 11/3.3 kV grade joints and terminations shall be type tested as per IS: 13573. Critical components used in cable accessories shall be of tested and proven quality as per relevant product specification/ESI specification. Kit contents shall be supplied from the same source as were used for type testing. The kit shall be complete with the aluminium solder less crimping type cable lugs & ferrule as per DIN standard.

5.06.02 Straight through joint and termination shall be capable of withstanding the fault level for 11 kV and 3.3 kV systems.

5.06.03 1.1 KV grade straight through joints shall be of proven design.

5.07.00 Cable glands

5.07.01 Cable glands shall conform to BS: 6121 and be of robust construction capable of clamping cable and cable armour (for armoured cables) firmly without injury to insulation. Cable glands shall be made of heavy duty brass machine finished and nickel chrome plated. Thickness of plating shall not be less than 10 micron. All washers and hardware shall also be made of brass with nickel chrome plating Rubber components shall be of neoprene and of tested quality. Necessary cable dimensions shall be furnished to the successful contractor.

5.07.02 Cable glands shall be single compression for indoor use, double compression type for outdoor use. Glands for classified hazardous areas shall be double compression type flameproof and weather proof duly certified by CMRS and approved by CCE.Cable glands shall match with the sizes of different HT/LT/Control cables.

5.08.00 Cable lugs/ferrules

5.08.01 The cables lugs shall be conforming to IS: 8309.

5.08.02 Machine ferruling shall be adopted.

5.08.03 Cable lugs for power cables shall be Aluminium solder less crimping type suitable for aluminium compacted conductor cables.

5.08.04 The cable lugs for control/instrumentation/ telephone cables shall be provided with insulating sleeve and shall suit the type of terminals provided on the equipments.
Cable lugs shall be suitable for termination of different cross-sections of control/ instrumentation /telephone cables and shall be of following types.

i) Copper tubular terminal end for solder less crimping to copper conductors.
ii) Cable lugs for control cable termination shall be insulated type. These lugs shall be flat type/ring type/U type to suit the terminals provided in the pan
iii) Pin type lugs shall not used.
iv) Aluminium tubular terminal ends for solder less crimping of to Aluminium conductor.

Solder less crimping of terminals shall be done by using corrosion inhibiting compound. The cable lugs shall suit the type of terminals provided on the equipment. Lugs for control/instrumentation cables shall be PVC insulated/sleeved type.

5.09.00 Cable Clamps & Straps

5.09.01 The cable clamps required to clamp multicore cables on vertical run shall be made up of Aluminium strip of 25x3 mm size. For clamping the multicore cables, self-locking, de-interlocking type nylon clamps/straps shall be used. The clamps/straps shall have sufficient strength and shall not get affected by direct exposure to sun rays and outdoor environment.

5.09.02 Trefoil clamps for single core cables shall be pressure die cast aluminum or fibre glass or nylon and shall include necessary fixing accessories like G.I. nuts, bolts, washers, etc. Trefoil clamps shall have adequate mechanical strength to withstand the forces generated by the system short circuit current of 105 KA peak.

5.10.00 Galvanizing

5.10.01 Galvanizing of steel components and accessories shall conform to IS: 2629 & IS: 2633. Additionally galvanizing shall be uniform, clean smooth, continuous and free from acid spots

5.10.02 The amount of zinc deposit over threaded portion of bolts, nuts, screws and washers shall be as per IS: 1367. The removal of extra zinc on threaded portion of components shall be carefully done to ensure that the threads shall have the required zinc coating on them as specified.

5.11.00 Welding

5.11.01 The welding shall be carried out in accordance with IS: 9595. All welding procedures and welders qualification shall also be followed strictly in line with IS: 9595.

6.00.00 CONSUMABLES AND HARDWARE

i. The contractor shall furnish all erection matreials, hardware and consumables required to complete the installation.

ii. The materials shall include but not limited to the following:

iii. Consumables: Welding rods & gas, oil and grease, cleaning fluids, paints, electrical tape, soldering matreials etc.

iv. Hardware: Bolts, nuts, washers, screws, brackets, supports, clamps, hangers, saddles, cleats, sills, shims etc.

v. Supply of cement, sand, stone etc. required for the execution of the contract shall be the responsibility of the Contractor.

7.00.00 METHODS AND WORKMANSHIP

i. All work shall be installed in a first class, neat workmanlike manner by mechanics/electricians skilled in the trade involved.

ii. The erection work shall be supervised by competent supervisors holding relevant supervisory license from the government.

iii. All details on installtion shall be electrically and mechanically correct.

iv. The installation shall be carried out in such a manner as to preserve access to other equipment installed.

8.00.00 INSTALLATION

8.00.01 Cable tray and Support System Installation

08.01.01 Cables shall run in cable trays mounted horizontally or vertically on cable tray support system which in turn shall be supported from floor, ceiling, overhead structures, trestles, pipe racks, trenches or other building structures. All cable trays shall be in vertical configuration in boiler, CHP, AHP & ESP areas.

8.01.02 Horizontally running cable trays shall be clamped by bolting to cantilever arms and vertically running cable trays shall be bolted to main support channel by suitable bracket/clamps on both top and bottom side rails at an interval of 1500 mm. For vertical cable risers/shafts cable trays shall be supported at an interval of 1000 mm. Fixing of cable trays to cantilever arms or main support channel by welding shall not be accepted. Cable tray installation shall generally be carried out as per relevant Standard. The cantilever arms shall be positioned on the main support channel with a minimum vertical spacing of 300 mm unless otherwise indicated in the relevant approved tray layout drawings.

8.01.03 All cable way sections shall have identification, designations as per approved cable way layout as and painted/stenciled at each end of cable way and where there is a branch connection to another cable way. Minimum height of letter shall be not less than 75 mm. For long lengths of trays, the identification shall be painted at every 10 meter. Risers shall additionally be painted/ stenciled with identification numbers at every floor.

8.01.04 In certain cases it may be necessary to site fabricate portions of trays, supports and other non standard bends where the normal prefabricated trays, supports and accessories may not be suitable. In such cases the Contractor shall fabricate at site suitable sections of trays, supports and accessories to make the installation complete for the specific purpose after obtaining owner's prior approval, which shall be neat in appearance and shall match with the prefabricated sections in the dimensions. They shall be applied with one coat of red lead primer, one coat of oil primer followed by two finishing coats of aluminium paint.

9.00.00 Conduits/Pipes/Ducts Installation

9.01.00 The Contractor shall be fully responsible for properly embedding conduit pipe sleeves wherever necessary for cabling work. All openings in the floor/roof/wall / cable tunnel/cable trenches made for conduit installation shall be sealed and made water proof by the Contractor.

9.02.00 GI pull wire of adequate size shall be laid in all conduits before installation. Metallic conduit runs at termination shall have two lock nuts wherever required for junction boxes etc.

9.03.00 Conduit runs/sleeves shall be provided with PVC bushings having round edge at each end. All conduits/pipes shall have their ends closed by caps until cables are pulled. After cables are pulled, the ends of conduits/pipes shall be sealed with Glass wool/Cement Mortar/Putty to prevent entrance of moisture and foreign material.

9.04.00 Cable routing between lined cable trench and equipment/motors shall be taken through GI pipe sleeves of adequate size. Pipe sleeves shall be laid at an angle of maximum 150 to the trench wall. In case of larger dia cables i.e. 50mm and above, adequately sized pipe with larger bend radius shall be provided for ease of drawing of cable or for replacement. In places where it is not possible, a smaller trench may be provided if approved by Site Engineer.

9.05.00 Exposed conduit/pipe shall be adequately supported by racks, clamps, straps or by other approved means. Conduits /pipe support shall be installed square and true to line and grade with an average spacing between the supports as given below, unless specified otherwise

Conduit /pipe size (dia).	**Spacing**
Up to 40 mm	1 M
50 mm	2.0 M
65-85 mm	2.5 M
100 mm	3.0 M

9.06.00 In areas like WTP, chemical handling, battery room etc. exterior surface of the conduits shall be further coated with chromate or polymer for better resistance to corrosion.

9.07.00 All G.I. pipes shall be laid as per approved layout drawings and site requirements. Before fabrication of various profiles of pipe by hydraulically operated bending machine (which is to be arranged by the contractor), all the burrs from the pipes shall be removed. The bends formed shall be smooth. GI Pipes with bends shall be buried in oil/concrete in such way that that the bends shall be totally concealed. For GI pipes shall be undertaken well before paving is completed and necessary co-ordination with paving agency shall be the responsibility of Electrical Contractor. The open ends of pipes shall be suitably plugged with G.I. plugs after they are laid in final position. G.I. plugs shall be supplied by the contractor at no extra cost.

10.00.00 Junction Boxes Installation

10.01.00 Junction boxes shall be mounted at a height of 1200mm above floor level or as specified in the approved drawings or as decided by Owner and shall be adequately supported/mounted on masonry wall by means of anchor fasteners/ expandable bolts or shall be mounted on an angle, plate or other structural supports fixed to floor, wall, ceiling or equipment foundations.

11.00.00 Cable Laying and Installation

11.01.00 Cable network shall include power, control, lighting, communication and fire alarm system cables, which shall be laid in trenches, cables trays/conduits as detailed in the approved drawings and cable schedules. Erection of cable trays

and aligning and leveling as required shall be the responsibility of the contractor.

11.02.00 Cable installation shall be carried out as per IS: 1255 and other applicable standards. Cable drums shall be unloaded, handled and stored in an approved manner on hard and well drained surface so that they may not sink. In no case shall be drum be stored flat i.e. with flange horizontal. Rolling of drums shall be avoided as far as possible. For short distances, the drums may be rolled provided they are rolled slowly and in proper direction as marked on the drum. In absence of any indication, the drums may be rolled in the same direction as it was rolled during taking up the cables. For unreeling the cable, the drum shall be mounted on suitable jacks or on cable wheels and shall be rolled slowly so that cable comes out over the drum and not from below. All possible care shall be taken during unreeling and laying to avoid damage due to twist, kink or sharp bends. Cable ends shall be provided with sealed plastic caps to prevent damage and ingress of moisture.

11.03.00a. In outdoor areas, buried cables, wherever called for, shall be laid and covered with sand/riddled earth and protected from damage by bricks at sides and precast slab at top.

b. When buried cables cross road/railway track, additional protection shall be provided in the form of hume / galvanised iron pipes/RCC box culvert.

11.04.00 For coal handling plant the cables shall not be routed along conveyor galleries. The cables shall be routed on independent cable trestles.

11.05.00 All tray levels shall be checked after erection and marked in as built drawings. Cable routing given on the layout drawings shall be checked in the field to avoid interference with structures, heat sources, drains, piping, air-conditioning duct etc. and minor adjustments shall be done to suit the field conditions wherever deemed necessary. All tray runs shall be installed parallel to the trench/building walls and floors except otherwise noted in the approved drawings. The contractor shall have to secure rack/tray supports by welding to those inserts, suitable embedded steel inserts shall be provided. Outdoor trays shall be installed by welding on the steel/concrete structure with inserts by the contractor. As far as practicable, cable trays shall be supported from one side only in order to facilitate installation and maintenance of cables from the other side.

11.06.00 While laying cable, ground rollers shall be used at every 2 metre interval to avoid cable touching ground. The cables shall be pushed over the rollers by a gang of people positioned in between the rollers. Cables shall not be pulled from the end without having intermediate pushing arrangements. Pulling tension shall not exceed the values recommended by cable manufacturer. Selection of cable drums for each run shall be so planned so as to avoid using straight through joints. Care should be taken while laying the cables so as to avoid damage to cables.

11.07.00 All temporary ends of cables must be protected against dirt and moisture to prevent damage to the insulation. For this purpose, ends of all cables shall be tapped with an approved PVC or rubber insulating tape. Use of friction type or other fabric type tape is not permitted.

11.08.00 Cables installed above grade shall be run in trays, exposed on walls, ceilings or structures and shall be run parallel or at right angles to beams, walls columns. Cables shall be so routed that they will not be subjected to heat from adjacent hot piping or vessels.

12.00.00 Laying of cables in cable trays

12.01.00 Cables shall be laid on cable trays strictly in line with cable schedule furnished. Where specific cable layouts are not shown on approved drawings, contractor shall route these as directed by the Owner.

12.02.00 Power and control cables shall be laid on separate tiers. The laying of different voltage grade cables shall be on different tiers according to the voltage grade of the cables. In horizontal tray stacks, H.V. cables shall be laid on topmost tier and cables of subsequent lower voltage grades on lower tiers of trays. Single core cable in trefoil formation shall be laid with a distance of four times the diameter of cable between trefoil center lines and clamped at every two metre. All multicore cables shall be laid in touching formation. LT power cables above 95 sq.mm size shall be laid in single layer touching formation in trays while cables upto & including 95 sq.mm shall be laid in maximum of 2 layers. Control and Instrumentation cables can be laid upto a maximum of three layers in each tray.

12.02.00 All communication cables (telephone, P.A. System) RTD Cables shall run on instrument trays/ducts/trenches. Wherever these are not available, cables shall be taken in a separate trench/trays with a minimum clearance of 600mm away from electrical trench/trays as per the direction of Site Engineer and Communication cables shall cross power cables at right angles

12.03.00 Power and control cables shall be secured fixed to trays/support with self locking type nylon cable straps with de-interlocking facilities. For horizontal trays arrangements, multicore power cables and control cables shall be secured at every five meter interval. For vertical tray arrangement, individual multicore power cables and control cables shall be secured at every one meter by nylon cable strap. After completion of cable laying work in the particular vertical tray, all the control cables shall be binded to trays/supports by aluminium strips at every five meter interval and at every bend.

12.04.00 Bending radii for cables shall be as per manufacturer's recommendations and IS: 1255.

12.05.00 Individual cables or small groups which run along structures/walls etc will be clamped by means of 16 SWG GI saddles on 25x6mm saddle bars. The cost of saddle and saddle bars shall be deemed to have been included in the installation of cables. Alternatively small group of cables can be taken through 100mm slotted channel/ISMC 100.They shall be rightly supported on structural steel and masonry, individual or in groups as required, if drilling of steel must be drilled where the minimum weakening of the structure will result.

12.06.00 Cables shall be supported so as to prevent unsightly sagging. In general distance between supports shall be approximately 300mm for cables upto 25mm diameter and maximum 500mm for cables larger than 25mm dia and

cables laid in vertical run of cable trays shall be clamped at an interval of 900mm.

12.07.00 Where cables cross roads/rail tracks, the cables shall be laid in Hume pipe/PVC pipe. At road crossing and other places where cables enter pipe sleeves adequate bed of sand shall be given so that the cables do not slack and get damaged by pipe ends.the hume pipes shall be laid at a depth of minimum 1000mm such that cables are not damaged.

12.08.00 Power and Control Cables, as far as possible, shall be laid in complete, uncut lengths from one termination to the other. Straight through joints in power cable shall be allowed only in nearest of rare situation only after approval of owner.

12.09.00 Joints for less than 250 Meters run of cable shall not be permitted.

12.10.00 In each cable run some extra length shall be kept at suitable point to enable one LV/two HV straight through joints to made, should the cable develop fault at a later stage. Control cable termination inside equipment enclosure shall have sufficient lengths so that shifting of termination in terminal blocks can be done without requiring any splicing.

12.11.00 Wherever few cables are branching out from main trunk route troughs shall be used.

12.12.00 Cables shall be neatly arranged in the trays in such a manner so that criss-crossing is avoided and final take off to the motor/switchgear is facilitated. Arrangement of cables within the trays shall be the responsibility of the contractor.

12.13.00 The contractor shall ascertain the exact requirement of cable for a particular feeder by measuring at site and avoiding interference with structure, foundation, pipelines or any other works. Before the start of cable laying, cable drum schedule shall be prepared by electrical contractor and get that approved by site engineer to minimize/avoid straight through joints. The actual number of straight through joints required shall be worked out by the contractor. During the erection period the contractor shall furnish a monthly report on cable position in an approved proforma so as to keep the owner appraised of the position.

12.14.00 The installation work shall be carried out in a neat workman like manner & areas of work shall be cleaned of all scraps, water, etc. after the completion of work in each area every day. Contractor shall replace RCC/Steel trench covers after the Installation work in that particular area is completed or when further work is not likely to be taken up for some time.

12.15.00 Electrical cable trays exposed to hazardous process fluid shall be covered with detachable G.I. covers. The covers shall be suitable to resist wind forces.

For cables laid above ground in cable racks, asbestos sheeting of 3mm thickness shall be provided below the bottom cable tray to protect the cables from fire.

12.16.00 Supporting steel shall be painted before laying of cables. The painting shall be done with one coat of red lead paint and two coats of approved bituminous aluminium paint unless otherwise specified.

12.17.00 Separation

Sufficient spacing not less than 300mm shall be provided between different tiers of trays and maintained to permit adequate access for installation and maintenance of cables.

At least 300mm clearance shall be provided between :
- HV power & LV power cables,
- LV power & LV control/instrumentation cables,

12.19.00 Segregation
Segregation means physical isolation to prevent fire jumping.

Cables from two different services viz. supply from Station Board and Unit Board shall be segregated.

Interplant cables of station auxiliaries and unit critical drives shall be segregated in such a way that not more than half of the drives are lost in case of single incident of fire. Power and control cables for AC drives and corresponding emergency AC or DC drives shall be laid in segregated routes. Cable routes for one set of auxiliaries of same unit shall be segregated from the other set.

For Coal Handling Plant all the cables of one stream shall be segregated from the cables of the other stream and shall run on either side of the trestle.

13.00.00 Cable fire sealing

13.01.00 Cable/cable tray openings in walls and floors or through pipe sleeves from one area to another or from one elevation to another within the unit shall be seated by a fire proof sealing system (FPSS). The FPSS shall effectively prevent the spread of fire from the flaming to non-flaming side of a fire.

13.02.00 Wherever the cables/cable trays pass through walls/floors, fire proof cable penetration seals rated for one twenty (120) minutes shall be provided. This shall be by suitable block system using individual blocks with suitable framework or by silicon RTV foaming system. In case foaming system is offered, damming board, if used, shall not be considered for fire rating criteria. Any of the system offered shall be of proven type as per BS: 476 (Part-20) or equivalent standard.

13.03.00 In order to prevent fire propagation through cable penetrations, after laying, dressing & clamping of cables, all the openings shall be properly sealed by using Fire Stop Mortar Seal and Fire Retardant Cable coating compound. Also the cable runs both before and after the fire scale shall be suitably sprayed with anti-fire propagation liquid.

14.00.00 Cable laying in trenches

14.01.00 RCC cable trenches with removable covers will be provided by the contractor. Cables shall be laid in 3 or 4 tires in these trenches. Concrete cable trenches shall be filled with sand where specified to avoid accumulation of hazardous gases. RCC covers of trenches in process area shall be effectively sealed to avoid ingress of chemicals etc. Removal of concrete covers for purposes of

cable laying and reinstating them in their proper positions after the cables are laid shall be done by the contractor at no extra cost.

14.02.00 For cable trays are laid in trench in more than two tiers a space of minimum 600 mm shall be available for maintenance. In case two or more tiers of cable trays are running parallel along both sides of trench walls there shall be space of minimum 600 mm between them.

14.03.00 Cables shall be handled carefully during installation to prevent mechanical injury to the cables. Ends of cable leaving trenches shall be coiled and provided with a protective pipe or cover tilt such times the final termination to the equipment is completed.

14.04.00 Prior to laying of cables inside both indoor and outdoor trenches, the contractor shall properly clean inside of those trenches.

14.05.00 When cables are laid in multiple tiers, spacing between individual tiers shall be as approved by Site Engineer. Space between individual tiers shall be filled and compacted with soil and sand.

14.06.00 As each row of cables is laid in place and before covering with sand every cable shall be given on insulation test in the presence of Site Engineer. Any cable, which proves defective, shall be replaced before the next groups of cables are laid.

14.07.00 All wall openings/pipe sleeves shall be effectively sealed after installation of cables to avoid seepage of water inside building/lined trench.

14.08.00 Where cables rise from trenches to motor, control station, lighting panels etc., they shall be taken in G.I. Pipes for mechanical protection up to a minimum of 150mm above grade.

14.09.00 Cable ends shall be carefully pulled through the conduit, to prevent damage to these cables. Where required, approved cable lubricant shall be used for this purpose. Where cable enters conduit the cable should be bent in large radius. Radius shall not be less than the recommended bending radius of the cables specified by the manufacturer.

Following guide of the pipe fill shall be used for sizing the pipe size:

a) 1 cable in pipe - 53% full
b) 2 cables in pipe - 51% full
c) 3 or more cables - 43% full
d) Multiple cables - 40% full

After the cables are installed and all testing is complete, conduit ends above grade shall be plugged with a suitable weatherproof plastic compound/'PUTTI' for sealing purpose. Alternatively G.I. Lids or PVC bushes shall be employed for sealing purposes. The cost for the same shall be deemed to have been included in the installation of G.I. pipe and no separate payment shall be allowed.

14.10.00 Where cables pass through foundation walls or other underground structures, the necessary ducts or openings will be provided in advance for the same. However, should it become necessary to cut holes in existing foundations or

structures, the electrical contractor shall determine their location and obtain approval of the Site Engineer before cutting is done.

15.00.00 CABLE IDENTIFICATION

15.01.00 Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct/conduit entry & exit, and at every 20 meters in cable tray/trench runs. Cable tags shall also be provided inside the switchgear, motor control centers, control and relay panels etc. where a number of cables enter together through a gland plate. Cable tag shall be of rectangular shape for power cables and control cables. Cable tag shall be of 2 mm thick aluminum with number punched on it and securely attached to the cable by not less than two turns of 20 SWG GI wire conforming to IS:280. Alternatively, the Contractor may also provide cable tags made of nylon, cable marking ties of 'TY-CAB' or equivalent type with cable number heat stamped on the cable tags.

15.02.00 For laying of underground cable (applicable for Raw Water Intake Switchgear & Ash dyke) shall be provided with identity tags of Stain less steel securely fastened every 30 M of its underground length with at least one tag at each end before the cable enters the ground. In unpaved areas cable trenches shall be identified by means of markers. These posts shall be placed at location of changes in the direction of cables and at intervals of not more than 30 M for straight run and at cable joint locations with additional inscription `Cable Joint'. For buried cables the marker shall project 150mm above ground.

15.03.00 Drum number of each cable from which it is taken shall be recorded against the cable number in the cable schedule.

16.00.00 CABLE TERMINATIONS & CONNECTIONS

16.01.00 The termination and connection of cables shall be done strictly in accordance with cable termination kit manufacturer'' instructions, drawings and/or as directed by Site Engineer. Cable jointer shall be qualified to carryout satisfactory cable jointing/termination. Contractor shall furnish for review documentary evidence/experience reports of the jointers to be deployed at site.

16.02.00 Work shall include all clamps, fittings etc. and clamping, fitting, fixing, plumbing, soldering, drilling, cutting, taping, preparation of cable end, crimping of lug, insulated sleeving over control cable lugs, heat shrinking (where applicable), connecting to cable terminal, shorting and grounding as required to complete the job to the satisfaction of the Site Engineer.

16.03.00 Responsibility of proper termination shall lie on the contractor. Guarantee for termination shall also have to be given by the contractor.

16.04.00 The equipment will be generally provided with undrilled gland plates for cables/conduit entry. The Contractor shall be responsible for punching of gland plates, painting and touching up. Holes shall not be made by gas cutting. The holes shall be true in shape. All cable entry points shall be sealed and made vermin and dust proof. Unused openings shall be effectively sealed by 2mm thick aluminium sheets.

16.05.00 Contractor shall drill holes for fixing glands wherever necessary at no extra cost. Gland plate shall be of non-magnetic material/aluminium sheet in case of single core cables. If the cable end box or terminal chamber provided on the equipment is found unsuitable and requires major modifications the same shall be carried out by the contractor at the discretion of the Engineer- in-Charge.

16.06.00 Control cable cores entering control panel/switchgear/MCC/miscellaneous panels shall be neatly bunched, clamped and tied with self locking type nylon cable ties with de interlocking facility to keep them in position.

16.07.00 The panels where a larger number of cables are to be terminated and cable identification may be difficult, each core ferrule shall include the complete cable number. The ferrules shall be indelible interlocking type and shall fit tightly on cores. Spare cores shall have similarly ferrules with a suffix letter 'S' alongwith cable numbers and coiled up after end sealing.

16.08.00 All cable terminations shall be appropriately tightened to ensure secure and reliable connections.

16.09.00 It is the responsibility of the Contractor to terminate the cables at motor terminals in correct phase sequence to ensure the proper direction of rotation.

16.10.00 All cables upto 1.1KV grade shall be terminated at the equipments by means of compression type cable glands. They shall have a screwed nipple with conduit electrical threads and check nut.

16.11.00 All cable entries shall be through bottom only and top entry terminations are made only after getting approval of Site Engineer.

16.12.00 Power cables, wherever colour coding is not available, shall be identified with red, yellow and blue PVC tapes. Where copper to aluminium connections is made, necessary bimetallic washers shall be used. For trip circuit identification additional red ferrules shall be used only in the particular cores of control cables at the termination points in the Switchgear/Control panels and Control Switches.

16.13.00 In case of control cables all cores shall be identified at both ends by their terminal numbers by means of PVC ferrules. Wire numbers shall be as per schematic/ wiring/ inter-connection diagram. Contractors shall have the samples of PVC markers approved before starting the work. All unused spare cores of control cables shall be neatly bunched and ferruled with cable tag at both ends. Control cables shall be neatly bunched and served with PVC perforated tape to keep it in position at the terminal block.

16.14.00 Where threaded cable gland is screwed into threaded opening of different size, suitable brass threaded reducing bushing shall be used provided.

16.15.00 The cable shall be taken through glands inside the panels or any other electrical equipment such as motors. The individual cores shall then be dressed and taken along the cable ways (if provided) or shall be fixed to the panels with polyethylene straps. Only control cables of single strand and lighting cables may be directly terminated on to the terminals.

In case of termination of cables at the bottom of a panel over a cable trench having no access from the bottom, close fit hole should be drilled in the bottom plate for all the cables in one line, and then bottom plate should be split in two parts along the centre line of holes. After installation of bottom plate and cables it should be sealed with cold setting compound. Cables shall be clamped over the open armouring to connect it to earth bus.

16.16.00 Cable leads shall be terminated at the equipment terminals by means of crimped type solder less connectors.

Crimping shall be done by hand crimping/hydraulically-operated tool and conducting jelly shall be applied on the conductor.

Insulation of the leads should be removed immediately before the crimping. Conductor surface shall be cleaned and shall not be left open.

16.17.00 Termination and connection shall be carried out in such a manner as to avoid strain on the terminals.

16.18.00 All cable entry points shall be properly sealed and made dust and vermin proof. Unusual opening, if any, shall be effectively closed. Sealing work shall be carried out with approved sealing compound having fire withstand capability for at least one-twenty (120) minutes.

17.00.00 Cable accessories for H.V. Systems

17.01.00 The H.V. cables terminations/joints shall be done by skilled and experienced jointers duly approved by the Site Engineer.

17.02.00 The termination and straight through joint kits for use on high voltage system shall be suitable for the type of cables offered by the contractor or the type of cables issued by owner for installation. The materials required for termination and straight through joints shall be supplied in kit form. The kit shall include all insulating and sealing materials apart from conductor fittings and consumable items. An installation instruction shall be included in each kid.

17.03.00 The termination kits shall be suitable for termination of the cables to an indoor switchgear or to a weatherproof cable box of an outdoor mounted transformer/motor. The termination kits shall preferably be as of the following types.

a. 'PUSH ON' type for LV cables.
b. Heat-shrinkable sleeve type for LV & HV cables.

However, termination kits for HV cables shall be of Heat Shrinkable type of makes with specific approval of owner.

For outdoor installations, weather shields/sealing ends and any other accessories required shall also form part of the kit.

17.04.00 The straight through jointing kits shall be suitable for underground buried installation with uncontrolled backfill and possibility of flooding by water. The jointing kit shall be one of the following types.

a. 'TAPEX' of M-seal make or equivalent for LV cables
b. Heat-shrinkable sleeve type for LV & HV cables.

However, termination kits for HV cables shall be of Heat Shrinkable type of makes with specific approval of owner.

For outdoor installations, weather shields/sealing ends and any other accessories required shall also form part of the kit.

18.00.00 EXCAVATION AND BACK FILLING

18.01.00 The contractor shall perform all excavations and backfilling as required for buried cable and ground connections.

18.02.00 Excavation shall be performed up to the required depth. Such sheeting and shoring shall be done as may be necessary for protection of the work.

18.03.00 The contractor shall make use of his own arrangement for pumping out any water that may be accumulated in the excavation.

18.04.00 All excavation shall be backfilled to the original level with good consolidation.

19.00.00 CLEANING UP OF WORK SITE

19.01.00 The Contractor shall, from time to time, remove all rubbish resulating from execution of his work. No materilas shall be stored or placed on passage or drive ways.

19.02.00 Upon completion of work, the contractor shall remove all rubbish, tools, scaffoldings, temporary structures and surplus materials etc. to leave the premises clean and fit for use.

20.00.00 QUALITY ASSURANCE PROGRAMME

20.01.00 Contractor shall furnish detailed Quality Assurance Programme and Quality Plans for all materials and accessories to be supplied and installed under the scope of the specification as per General Technical Conditions of technical specification. The Quality Plans shall include all tests/ checks as per relevant National/International Standards and the requirements of this specification including tests listed in this section.

21.00.00 TESTS

21.01.01 Type tests on Cable Trays support system

A) Test 1A:
On main support channel type-C2 for cantilever arms fixed on one side only. A 3.5 metre length of main support channel shall be fixed vertically at each end to a rigid structure as per appropriate fixing arrangement. Eight (8) nos. 750 mm cantilever arms shall be fixed to the main channel and each arm shall be loaded over the outboard 600 mm with a uniform working load of 100 kg. Subsequently a point load of 100 kg shall be applied on arm 2. A uniform proof load on all the arms equal to twice the working load shall be then be applied. Deflections shall be measured at the following load intervals and other necessary points:
i) Working load

ii) Working load + point load
iii) Off load
iv) Proof load + point load
v) Off load

The deflection measured at working loads shall not exceed 16 mm. The permanent deflection after removing the combination of working load and point load shall not exceed 10 mm at the arm tips and 6 mm on the channel. No collapse of the structure shall occur with a combination of proof load and point load applied.

B) Test 1B:

Test 1A shall be repeated with Eight Cantilever arms uniformly loaded and with the same point load on arm 2

Test 2: On Main support channel type -C2 for cantilever arms fixed on both sides

a)Test 2A: A 3.5 m length of main support channel C2 for cantilever arms fixing on both sides shall be fixed at each end to rigid structure as per appropriate fixing arrangement. Six (6), 750 mm cantilever arms shall be attached to each sides and each arm uniformly loaded to a working load of 100 kg over the out board 600 mm. A point load of 100 kg shall than be applied to arm 2, followed by a uniform proof load of twice the working load on all the arms; deflection shall be measured at the following load intervals and other necessary points.

i) Working load
ii) Working load + Point load
iii) Off load
iv) Proof load + Point load
v) Off load

The deflection measured at working loads shall not exceed 16mm. The permanent deflection after removing the combination of working load and point load shall not exceed 10 mm at the arm tips and 6 mm on the channel. No collapse of the structure shall occur with a combination of proof load and point load applied

b) Test 2B: The test 2 A shall be repeated with the assembly but with an asymmetrical load on the C2 column and point load applied to arm 8. The 100 kg and 200 kg uniformly distributed loads shall be applied to the upper three arms on one side and the lower three arms on the opposite side.

Test 3:

A length of main support channel section shall be fixed to steel structure/floor and have loads applied as detailed below and other important points not mentioned herein.

a) **Test 3A :** A length of steel structure shall be rigidly supported. It should be fitted on a metre length of channel section using beam clamps welded/bolted. A point load of 1200 kg shall be applied to the centre point via two brackets. No distortion or pulling of the components shall take place.

b) **Test 3B:** With the components assembled as in Test 3A, two perpendicular point loads of 600 kg shall be simultaneously applied at positions 150 mm either side of the centre line, no distortion or pulling of the components shall take place.

c) **Test 3C:** With the components assembled as in Test 3A, a perpendicular point load shall be applied at a point 150 mm on one side of the centre line.
The load shall be gradually increased to the maximum value that can be applied without causing distortion or pulling of the components. This value shall be recorded.

Test 4 Channel nut slip characteristics (what ever applicable)

Tests 4A1, 4A2, 4A3:
A length of channel C1 section 200 mm long shall have fitted bracket with the two bolts fixing.

With loads applied at the appropriate position nut slip shall be determined with bolt torque of 30 NM, 50 NM and 65 NM No fewer than three measurements shall be made or each torque setting.

A minimum loading of 720 kg shall be obtained before nut slip with bolt torque of 65 NM.

Tests 4B1, 4B2, 4B3:

The length of channel C1 section 200 mm long shall have fitted bracket with the one bolt fixing. With loads applied at the appropriate position, nut slip shall be determined with bolt torques of 30 NM, 50 NM and 65 NM. No fewer than three measurements shall be made for each torque setting.
A minimum loading of 350 kg shall be obtained before nut slip with a bolt torque of 65 NM

Test 5 Weld Integrity Test
After deflection test as per test 1A, 1B, 2, 3 & 4 weld integrity shall be checked by magnetic particle inspection to detect sub-surface cracks developed, if any.

Cable termination kit and straight through joints should have been tested as per IS: 13573 for 3.3kV and 11kV class.

Fire proof Cable Penetration system should have been tested for the following tests:
a) Accelerated Ageing test
b) Water absorption test
c) Fire rating test
d) Hose Stream test
e) Vibration test followed by fire rating test

21.02.00 Routine/ Acceptance Tests

Following routine/acceptance tests shall be carried out on all the equipments, devices & materials supplied:

22.00.00 Galvanizing Tests

The quality of galvanizing shall be inspected visually and shall be smooth, continuous, and free from flux stains.

i) Uniformity of coating – The coating of any article shall withstand four 1 minute dips in standard copper sulphate solution without the formation of an adherent red spot of metallic copper upon the basic metal.

ii) The quality of cadmium/zinc plating on items with screw threads shall be inspected visually and shall be free from visible defects such as unplanted areas, blisters and modules.

iii) In addition, the plating thickness shall be determined microscopically/chemically or electronically.

23.00.00 Welding

The quality of welding shall be visually inspected, particular attention being paid to the following points.

1) The welded joints shall be continuous along its length on both sides and of uniform width and thickness. It should be free from blow holes.

2). The weld metal shall be properly fused with the parent metal without undercutting.

3) The outside surface of the weld shall be clean. All slag shall have been removed. All welding shall be regularly checked for cracking using magnetic particle inspection or their equivalent technique.

1. Physical and dimensional checks for all items.
2. All conduits/pipes, etc. shall be routine/acceptance tested as per relevant standards.
3. All acceptance and routine tests on cable glands as for BS: 6121. Additionally Proof torque test shall be carried out as acceptance on each body group of cable glands.
4. Deflection test cable trays.
5. All acceptance and routine tests on junction boxes.
6. Following tests shall also be carried out on each type of equipments, devices and materials/items supplied:
   i) Physical and Dimensional checks
   ii) Check/measurement of thickness for Nickel chrome plating for cable glands and tinning for cable lugs.
   iii) Check chemical composition of brass parts for cable glands.
   iv) Hardness check on gaskets.
   v) Test for uniformity of galvanization.

24.00.00 Cable trays / supports and accessories

1) Check for proper galvanizing/painting and identification number of the cable trays/supports and accessories.
2) Check for continuity of cable trays over the entire route.
3) Check that all sharp corners, burrs, and waste materials have been removed from the trays supports.
4) Check for earth continuity and earth connection of cable trays.

QUALITY PLAN FOR MOTORS BELOW 55 KW (LV)

		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

QUALITY PLAN FOR MOTORS 55 KW & ABOVE

		QUALITY PLAN	CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :				
			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	W	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	W	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		
	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 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**	
	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 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	W	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**	
	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 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 P	AGENCY W	AGENCY V	REMARKS
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			REMARKS
									P	**W**	**V**	
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			REMARKS
									P	**W**	**V**	
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

1.0	Design ambient temperature	:	50 ^{o}C
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		
	○ 110kW & Above (Breaker controlled)	:	50 kA for 1 sec
	○ Below 110kW (SFU+ Contactor controlled)	:	50 KA for 0.20 sec.
	f) LV System grounding	:	Solidly
7.0	Class of insulation	:	Refer clause 7.03.00 of Customer Motor Specification
8.0	Minimum voltage for starting (As percentage of rated voltage)	:	Refer clause 6.03.00 of Customer Motor Specification
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 upto 0.20 kW
13.0	Tests	:	As per Customer motor spec. (enclosed)
14.0	Energy efficient/ Flame proof motor	:	CLASS IE3

- **Also detail Customer spec. for Motors to be referred as enclosed with the specification.**

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		

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	

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.	426	ORIGINATING AGENCY		PEM (ELECTRICAL)	
	PROJECT TITLE	1X660MW PANKI TPS EXTN	NAME		DATA FILLED UP ON	
	SYSTEM	SEWAGETREATMENT PLANT	SIGN.		DATA ENTERED ON	
	DEPTT. / SECTION	MAUX 184/500	SHEET 1 OF 1	REV. 00	DE'S SIGN. & DATE	

BHEL Cable Listing Format

ANNEXURE III

CABLE NO.	FROM	TO	PURPOSE	CABLE SCOPE (BHEL PEM/VENDOR)	REMARKS	CABLE SIZE	PATH CABLE NO

CHAPTER 19 : VARIABLE FREQUENCY DRIVE

1.00.00 CODES AND STANDARDS

DC reactor – IEC 60289
HT Circuit Breaker – IEC 60056
Motors – IS 60325 / IEC 60034 / IS 4722
Transformers – IS 2026
Bushings – IS 2099 / IEC 60137
Bushing CT – IEC 60185 / IS 2705
DRY Type Transformer – IS 11171
Harmonics & EM Compatibilty – IEEe: 519/IEC: 61000
Contactor/Switches/Fuses etc. – IEC: 60947, IS: 13947

2.00.00 TYPE

The Variable frequency drive (VFD) system shall be of a modern proven design for similar applications in power plants. The system shall be either Current Source Inverter (CSI) or Voltage Source Inverter (VSI) type with Twelve (12) pulse design for HCSD pumps (for AHP) & pipe conveyors (for External CHP) and six (6) pulse design for Rotary feeders(for AHP). Alternatively the contractor may offer technically superior and proven product subject to the approval of employer.

3.00.00 PERFORMANCE REQUIREMENTS

3.01.00 The system shall be energy efficient, designed as standard product and shall provide very high reliability, high power factor, low harmonic distortion and low vibration / wear/ noise.

3.02.00 The system shall be designed to deliver the motor input current and torque for the complete speed torque characteristics of the pump, with input supply variation of $\pm$10% and frequency variation of +3% & -5%. It shall be capable of withstanding the thermal and dynamic stresses and the transient mechanical torque, resulting from short circuit.

3.03.00 The drive system shall be designed to operate in one or more of the following operating modes as to suit characteristics of the driven equipment:

- Variable torque changing as a function of speed i.e. speed squared
- Constant torque over a specific speed range
- Constant power over a specific speed range where the torque decreases when speed increases

3.04.00 The drive controller shall be equipped with microprocessor based digital regulator with programmable functions. The power control regulator logic shall provide for an acceleration/deceleration current limit curve and shall be capable of field be separately programmable from 0.1 to 20 seconds.

3.05.00 Each channel and motor rating shall be rated to meet pump requirements. The system shall be designed for linear continuous speed control from 10% to 100% of pump rated speed and shall be of a modern proven design and fully compatible with excitation system offered.

3.06.00 The Total Harmonic Distortion (THD) of the voltage and current at inverter output shall be as per IEC 61800-4 and it shall be considered in the design of

the motor.

3.07.00 Harmonics at the supply side of the drive system at primary of the main input transformer shall be restricted within the maximum allowable levels of current and voltage distortion as per recommendations in the latest edition of IEEE-519.

3.08.00 The overload capacity of the controller shall be 150% of rated current of motor for one minute for constant torque applications, and 115% of rated current for one minute for variable torque application at rated voltage. If the motor load exceeds the limit, the drive shall automatically reduce the frequency and voltage to the motor to guard against overload. If the load demand exceeds the current limit for more than one (1) minute, the drive shall shut down to prevent overheating of the motor and damage to the drive.

3.09.00 During operation, the system shall be capable of developing sufficient torque under all load condition to respond to a 20% alteration in speed set point within a time limit up to 60 seconds.

3.10.00 The integrator action of the speed set point alteration shall be independently adjustable for both an upward and downward alteration. The minimum time interval between set point adjustments by the distributed control system shall be considered as 10 second.

3.11.00 The drive shall trip incase the speed exceeds 105% of the maximum operational speed or reduces to 95% of the minimum operational speed for more than 10 second.

3.12.00 Maximum noise level from the drive at 1meter distance, under rated load with all normal cooling fans operating shall not exceed 85dBA.

3.13.00 Variable frequency drive shall be arranged so that it can be operated in a circuit mode, disconnected from the motor for start up adjustment and troubleshooting/ maintenance.

3.14.00 Voltage at motor neutral terminal shall be maintained at ground potential for the total operating condition.

3.15.00 The drive system shall ensure the following:

- Harmful VFD induced harmonics which can create motor heating are eliminated.
- VFD induced torque pulsation are limited to maximum 1% (even at low speed) so there is minimal stress to the equipment.
- Motor is protected from dv/dt stresses.
- No appreciable increase in motor audible noise.

3.16.00 Electrical performance of the system shall comply to IEEE, IEC and equivalent international standard.

4.00.00 CONTROL REQUIREMENT

4.01.00 The system shall operate on constant V/f supply with required voltage boost capability in low frequency mode of operation.

4.02.00 Short time voltage dip up to 20% of nominal voltage (e.g. in case of a large motor start up connected to the same bus as VFD) shall not cause the control system to stop functioning and shall not trip the drive system.

4.03.00 The system shall also be equipped with a facility which will restart the system in case of voltage dip over 20% or power interrupter for less than 2 seconds, with recovery of the voltage to its normal value. The drive shall have the facility to block this feature, if required by operator. Upon restart the converter shall be capable of synchronizing onto a rotating motor and develop full acceleration torque within 10 seconds.

4.04.00 The power controller shall be controlled to always start the motor in the forward direction. Logic shall be provided to prevent the motor from being started in the reverse direction.

4.05.00 The drive motor shall be speed controlled corresponding to 4-20mA or 0-10V reference input signal. Unless otherwise specified, upon complete loss of the users speed reference signal, the drive shall automatically run at constant speed as at 8-100% of the last speed reference available prior to the loss of signal.

4.06.00 It shall be possible to vary the speed of the drive in either manual or auto mode. Auto/manual selection shall be from VFD panel unless otherwise specified.

- With the selector switch in "manual" mode, the operator shall be able to set the speed through keypad, mounted on front of the drive panel or from speed increase/decrease push buttons from the field. Motor operated potentiometer shall be provided as a speed set point device.

- With selector switch in "auto" mode, speed of the motor shall be controlled from a 4-20mA signal, from owner's PLC/DCS system. Necessary equipment like protocol converter as required for interfacing with PLC/DCS shall also be provided in the drive panel.

4.07.00 The required provision for the interface with remote PLC/DCS located at control room shall be either through hardwired connection (with potential free contacts and transducers as described elsewhere in this specification).

4.08.00 Drive system shall have provision for interface with upper level automation such as substation monitoring system or electrical control system.

4.09.00 The closed loop control feedback for the drive system having output transformer shall be tapped from the secondary side of the output transformer.

5.00.00 PANEL CONSTRUCTION

5.01.00 The panel shall include suitable semi conducting power devices (Diodes/IGBT) modules with protective devices, reactors (if required), filters (if required), control circuit, control accessories, indication and annunciation etc. The construction of the panel shall provide effective protection against electromagnetic emissions and shall meet design requirement of integrated standards.

5.02.00 Upstream breaker "ON/OFF/TRIP" indications and remote breaker closing and

trip push button shall be provided on the front door.

5.03.00 Safety Interlock shall be provided so that power cabinet can't be opened unless the up stream breaker is disconnected, safety-grounding switch is closed and DC link capacitor is discharged. Power source breaker can only be closed once the earthing switch is open and panel door is closed with lock defeat facility.

5.04.00 Duplicate control supply with automatic changeover shall be provided. Protection shall be provided against AC/DC transients, voltage surge etc. of power and control device.

5.05.00 The drive shall be housed in sheet steel panels fabricated with 2mm thick cold rolled sheet steel. The panel shall be suitable for indoor installation, if not otherwise specified. The panel shall be free standing with degree of enclosure protection as IP-41. The maximum operating height shall be 1800mm approximately.

5.06.00 Bolted un-drilled gland plate shall be provided at bottom. Clamp type terminals shall be used for connection of all wires up to 10mm2 and terminal for higher sizes shall be bolted type suitable for cable lugs. Minimum space for power cable termination shall be 600mm clear from bottom of the cable gland plate.

5.07.00 Bus bars shall be of electrolytic copper, color coded separately for AC and DC system. All the live parts shall be sleeved/shrouded to ensure complete safety to personnel intending to carry out routine inspection by opening the panel doors. All the equipment inside the panel and on the doors shall be provided with suitable nameplate.

5.08.00 All the switches, component and accessories which are essential for normal and emergency operation shall be mounted on the door and shall be operable externally. All the analog instruments, where provided, shall be switchboard type, back connected; 72x72mm.Scale shall have red mark indicating maximum permissible operating rating.

5.09.00 Each panel shall be provided with illuminating lamp/11W CFL with switch and fuse. 5/15A, 240V power socket with switch and fuse shall be provided. Each panel shall have space heater with switch fuse and variable setting thermostat.

5.10.00 Copper earth bus of min. 50x6 mm size shall be provided in the panel with provision for connection to purchaser's plant earth grid. All the non-metallic components /parts shall be connected to the main earth bus bar. Separate earth bus bar and stud for electronic control system as required shall be provided.

5.11.00 All the metal parts shall be treated so as to ensure efficient anti-corrosive protection. Hard wares shall be zinc passivated or electro galvanized. Panel enclosure and structure supports shall be thoroughly cleaned and degreased to remove mill scale and rust etc. External surface shall be painted Siemens grey (RAL - 7032) with two coats of synthetic enamel paint.

5.12.00 All panels shall be of same height so as to form a uniform line-up, to give good aesthetic appearance.

5.13.00 All the control wiring shall be enclosed in plastic/metal channel. Each wire shall be identified at both ends by self-sticking wire marker tapes of PVC ferrules. Power and control wiring inside the panel shall be done with BIS approved, PVC insulated, fire retardant, copper conductor wire. 1.5mm2 size wire shall normally be used provided the control fuse rating is 10 Amps or less and 2.5mm2 size for control fuse rating above 16A for electrical circuits and 0.7 mm2 for electronic circuits. All wires shall be ferruled and terminals shall be properly numbered, minimum 20% spare terminal shall be provided.

5.14.00 All electronic modules and components shall be accessible from front of panel only. Modular assemblies for both the system control electronic equipment and power electronic equipments shall be used.

5.15.00 All low voltage compartment and cabling shall be electrically and physically separated from the high voltage compartment.

5.16.00 DC link capacitor and pre charging and discharging circuit shall be preferably mounted in the rear of the panel.

5.17.00 Suitable removable type hooks shall be provided for lifting the panel.

5.18.00 Perspex type transparent insulating material shall be used for covering live compartments.

5.19.00 Drive keypad, operator control panel required for control, monitoring and measurements shall be supplied and installed outside the panel on the front door. It shall be accessible for operation without opening the front door and shall be non-removable type.

5.20.00 All the equipment shall be complete with cable glands, lugs etc. and cable glands shall be single or double compression type for indoor and outdoor equipment respectively.

6.00.00 COOLING

6.01.00 The drive panel shall be naturally cooled type as per manufacturer's standards. If unavoidable, forced type cooling system shall be provided. Cooling system shall include well-dimensioned panel, adequate cooling airflow path, module cooling fan and if necessary, panel-cooling fan shall be considered. Vendor shall ensure that the panel dimensions and the flow paths have been designed for continuous running at the specified ambient without overheating. For fan cooled drives, redundant ventilating fans (N+1) shall be provided.

6.02.00 Necessary starters shall be provided within the VFD panels for the ventilation fans, any other auxiliary motor etc. The system provided shall be interfaced with drive starting and shut down such that safety interlocks such as start permit from cooling system to drive and trip signal from cooling system to drive in case of cooling system failure etc., shall be incorporated in the overall sequence logic.

6.03.00 MCB for motor space heater, auxiliary power supply if required for local panel, drive panel space etc. shall be included and mounted in easy accessible location.

7.00.00 EQUIPMENT/COMPONENT SPECIFICATION

7.01.00 Motor

i. The motor shall be suitable for operation with a solid-state power supply consisting of an adjustable frequency inverter for speed control.
ii. The motor shall be suitable for the current waveforms produced by the power supply including the harmonics generated by the drive.
iii. The motor shall be designed to operate continuously at any speed over the range 10-100 % of rated speed.
iv. The permitted voltage variation should take into account the steady state voltage drop across the AC drive and all other system components upstream of the motor.
v. Motors required to be transferred to DOL, by-pass mode shall be rated for specified variations in system line voltage and frequency. Starting current of motor in DOL, bypass mode shall be limited to value in motor specifications.
vi. The motor shall be constructed to withstand torque pulsations resulting from harmonics generated by the solid-state power supply.
vii. The motor insulation shall be designed to accept the applied voltage waveform, within the V_p and dv/dt limits as per IEC-61800-4.
viii. The drive manufacturer shall be solely responsible for proper selection of the motor for the given load application and the output characteristics of the drive.
ix. Other details shall be as given in section of Electric motors.

7.02.00 Power Transformers

Indoor dry type. and shall be suitable for rating complying with system details. Other details as given in chapter for Dry Type Transformer.

7.03.00 Power Converter

i. The static power shall consist of a line side power converter for operation as a rectifier and a load side power converter for operation as a fully controlled inverter. Power converter shall be fast switching, most efficient and low loss type.
ii. Adequate short circuit and over voltage protection shall be provided for the converter and inverter system.
iii. All power converter devices shall include protective devices, snubber networks and dv/dt networks as required.
iv. The current rating of the converter's semi-conductor components shall not be less than 120% of the nominal current flowing through the elements at full load of the VFD through the whole speed range.
v. All power diodes shall be of silicon type with minimum V_{bo} rating as 2.5 times the rated operating voltage.
vi. The power converter circuit shall be designed so that motor can be powered at its full nameplate rating continuously without exceeding its rated temperature rise due to harmonic currents generated by the inverter operation.
vii. The conversion devices and associated heat sinks shall be assembled such that individual devices can be replaced without requiring the use of any special precautions/tools.
viii. The cooling system of the electronic components, if provided, shall be monitored and necessary alarms shall be provided to prevent any consequential damage to the power control devices.

ix. Offered system shall also take in account the distance between drive panel and motor and system shall include all material and accessories to make system suitable for a distance of 350m.

7.04.00 DC Link Reactor

i. Smoothing reactors for the DC link shall be designed to sufficiently decouple the rectifier and inverter portion of the converter and to limit fault currents in this circuit.
ii. Unless otherwise specified, the reactor shall be dry type, air cored, air-cooled and housed in separate enclosure in ventilated room.
iii. Reactor shall be suitable for withstanding earth fault continuously and for operation with the non-sinusoidal current wave shapes and DC components under all operational conditions of the system without exceeding its temperature limits.
iv. Noise level shall not exceed value specified in NEMA TR-1 standard.

7.05.00 Output Filter

VFD output current waveform should be inherently sinusoidal at all speeds, with harmonic limits as specified in this specification. Output filter shall be provided if required. Output filter capacitors shall be provided with discharge circuits to ensure that all residual stored charge is reduced to less than 50 V DC within 300 seconds after a loss of AC voltage. All capacitor shall be maintenance free and self-healing type.

The VFD system shall inherently protect motor from high voltage dv/dt stress, independent of cable length to motor. Output filter shall be an integral part of the VFD system and included within the VFD enclosure.

7.06.00 Bypass Feature

i. Bypass breaker / contactor-HRC fuse complete with protection, annunciation and metering shall be provided.
ii. All Variable frequency drives (VFD) having bypass feature shall have motor protection relay along with necessary control and metering etc. Switching scheme shall be such that in case of drive mal-operation, the motor could be taken on bypass control manually, while the drive could be attended by opening its isolation devices.
iii. Safety interlock between inverter and bypass breaker/contactor shall be provided such that closing of healthy device is inhibited in case of external fault.

7.07.00 CT/PT/Meters

As required for the system offered and shall be suitable for variable frequency operation.

7.08.00 Local Motor Control Station

i. The local motor control station is to be installed in the field near the motor. Components and accessories that are required in the local motor control station may be mounted on the local field mounted panel envisaged for the driven equipment.

ii. Meters in the local control station shall be suitable for 4-20mA transducer outputs and shall be calibrated for the actual motor current. Further, the drives with bypass facility, the meters shall be capable of reading bypass full load and starting currents, as well as the drive current.

7.09.00 Protection, Metering, Control, Annunciation & Indication

i. The system vendor shall provide all the necessary system control, protection; alarm equipment and metering for the entire drive system and its auxiliary equipment.
ii. Automatic sequence control shall include start-up of cooling system, auxiliary system of the motor, interlock checking, automatic start and run-up of drive, planned and emergency shutdown. The same shall be processed through microprocessor-based system.

7.10.00 Operator Control Panel

i. Each drive shall be equipped with a front mounted operator control panel consisting of a backlit alphanumeric display and a keypad with keys for parameterization and adjusting parameter which shall be limited to Start/Stop, Local/Remote, Auto/Manual, Increase/Decrease, menu navigation and protection and measurement parameter selection, etc.

ii. All parameter names, fault messages, warnings and other information shall be displayed in complete English words or standard English abbreviations to allow the user to understand what is being displayed without the use of a manual or cross-reference table. This shall also be used for the modification of all electrical values, configuration parameters, drive menu parameters, application and activity function access, faults, local control, adjustment storage, self test and diagnostics. Keypad shall be operable with password for changing the protection setting, safety interlock etc. However the parameters such as measurements, setting, and mode of drive etc. shall be allowed to be viewed without any password.

iii. Operator console shall have facility / port to connect external hardware such as Lap-Top etc. Console shall have facility for upload and download of all parameter settings from one drive to another identical drive for start up and operation.

iv. Drive system control also have facility to receive tripping signal from up stream breaker for tripping and also provision for closing upstream breaker after all required process parameters are achieved.

v. User-friendly software for operation and fault diagnostic shall be loaded in the drive system panel before commissioning.

8.00.00 PANEL PROTECTIVE FEATURES

The system offered shall incorporate adequate features, properly coordinated for the drive control and for motor but not limited to the following:

i. Incoming line surge protection.
ii. Under / Over voltage protection.
iii. Phase loss, phase reversal protection.
iv. Programmable Over current Protection and under load protection.

v. Inverter fault.
vi. Over frequency operation.
vii. Ventilation loss.
viii. Over temperature of equipment.
ix. Over speed of motor.
x. Specific motor protection, including motor winding, bearing temperatures, over current, overload, negative phase sequence, locked rotor and earth fault protections etc.
xi. System earth fault protection.
xii. Over and under frequency, rotor earth fault, field failure protection for synchronous motor.
xiii. Additional protection for drive system.

9.00.00 CONTROL

The following controls shall be provided as a part of the operators control panel or through separate switches:

i. Start/stop
ii. Speed control (Raise/lower)
iii. Auto/Manual/Test mode
iv. Local/Remote
v. Emergency Stop
vi. Start/stop for by pass starter (where specified)
vii. Trip-Remote Breaker
viii. Sequential switching of filters

10.00.00 INDICATORS

Indications as required for normal operation and for easy maintenance, which shall be provided but limited to the following indications:

i. Motor running
ii. Motor stopped
iii. VFD system fault
iv. AC mains ON
v. Motor over speed.
vi. Rectifier output ON
vii. Motor zero speed
viii. Rectifier breaker trip.

Above indications may be provided as a part of the operator control panel, i.e., door mounted keypad or through hardwired indicating lamps/LEDs.

Potential free contacts of first five items shall be wired separately for remote indications in PLC/DCS system.

11.00.00 METERING

Digital display of the following parameters shall be as a part of the Operator Control Panel, selected by the operator.

i. Input AC Voltage
ii. Input AC frequency
iii. Input AC current
iv. Output voltage

v. Output current VFD/Bypass
vi. Output frequency
vii. Motor thermal state
viii. Drive thermal state
ix. Motor speed
x. Motor energy meter
xi. DC link voltage
xii. Hour run

Necessary transducer shall be provided with 4-20mA output for indicating motor speed and motor current in PLC/DCS unless otherwise specified for other parameters.

12.00.00 AUDIO VISUAL ANNUNCIATION

i. The system shall incorporate audio-visual annunciations for protection, for various fault conditions, for the Drive motor, Supply cables, DC Reactor and the Converter, output transformer etc.

ii. Alarms shall also be included for the failure of various auxiliaries together with identifications of the failing unit, loss of cooling system, various protections devices provided for converter transformer etc.

iii. Audio-visual window annunciations shall be provided on the front of the panel. All annunciations as required for normal and satisfactorily operation of the drive system shall be included as per vendor standards. These annunciations can be part of operator console panel or separately mounted type.

iv. Vendor shall include audio-visual alarm as required for normal operations and maintenance of the system but not limited to the following:

1. Rectifier fuse failure
2. Main AC failure
3. Inverter fuse failure
4. Inverter overload
5. Inverter high temperature
6. Cooling system failure
7. Motor failed to start
8. Transformer failure
9. Battery monitoring healthiness
10. Communication and measurement system unhealthy
11. Motor temperature high
12. Harmonic filters monitoring

Common potential free contacts shall be provided for above annunciations and these shall be wired up to terminal block for owner's use for remote alarm and monitoring.

13.00.00 FAULT DIAGNOSTIC

Fault diagnostic shall be built into the system to supervise the operation and failure of the system. The information regarding failure of any of the system including shut down of the system shall be available for a period of minimum 4 days (96 hours) after a shut down even though no supply would be available to the system. The system may be totally de-energized for maintenance or

otherwise. It shall be possible to retrieve the record of events prior to tripping of the system or de-energization. Auxiliary supply to the system components or to the electronics (firmware) for the diagnostics / display shall be taken care by the manufacturer for this purpose.

14.00.00 EXTERNAL POWER SUPPLY FOR AUXILIARY & CONTROL CIRCUIT

Auxiliary power supply for devices external to VFD module, space heater supply for Motor, VFD panel space heater, auxiliary power supply for transformers, cubicle 11W CFL lamps etc. shall operate on 240 volts single phase AC provided by purchaser.

All control circuit shall operate at maximum voltage of 240V AC.

Vendor shall include supply of all control transformers, protective devices, required accessories etc. and any other control supply voltage as required for the system shall be derived from the power supply made available by other.

15.00.00 MAINTENANCE FEATURES

The controller design shall incorporate the following maintenance features:

- Modular construction
- All components shall be easily accessible

Standard diagnostics to aid maintenance personnel. These shall include LED or alphanumeric displays, test or measurement points.

16.00.00 PAINTING

i. All metal surfaces shall be thoroughly cleaned and de-greased to remove mill scale, rust, grease and dirt. Fabricated structures shall be pickled and then rinsed to remove any trace of acid. The under-surface shall be prepared by applying a coat of phosphate paint and a coat of yellow zinc chromate primer. The under-surface shall be made free from all imperfections before undertaking the finishing coat.

ii. After preparation of the under surface, the panel shall be provided with epoxy based powder coating. Panel finish shall be free from imperfections like pinholes, orange peels, runoff painted.

iii. All unpainted steel parts shall be zinc passivated, cadmium plated or suitably treated to prevent rust and corrosion. If these parts are moving elements, then these shall be greased.

iv. Final paint shade shall be Siemens grey (RAL - 7032).

17.00.00 INSPECTION, TESTING AND ACCEPTANCE

i. During fabrication, the drive shall be subject to inspection by owner, or by an agency authorized by the owner, to assess the progress of work, as well as to ascertain that only quality raw material is used. The manufacturer shall furnish all necessary information concerning the supply to owner's inspectors.

ii. All tests shall be carried out at the manufacturer's works under his care and expense. The tests shall be witnessed by an inspector of the owner or

an agency authorized by the owner. Prior notice of minimum of 4 weeks shall be given to the inspector for witnessing the test.

iii. The routine test shall be conducted on all the drive system. However type test shall be performed on one system of each rating and type unless otherwise agreed between purchaser and manufacturer. For the purpose of testing, drive system shall include input/output transformer (where applicable), switchgears, converter, filters etc.

iv. All routine and type tests shall be conducted on the drive system as follows:

I. Routine tests:

1. Visual Inspection
   It involves checking of various equipments/components fault diagnostic unit, wiring, terminals, earthing ratings, etc, in line with the approved drawings and visual inspection shall not be limited to the following:
   - Dimensions and door layout according to approved layout drawing
   - Degree of protection of cubicles
   - Simulation facility of control signals for testing purposes
   - Memory function of fault diagnostics
   - Voltage/current rating power semiconductor elements
   - Cable termination size and number of terminals, cable supporting, etc
   - Accessibility of components
   - External signals and indication/alarm signals on converter
   - Earthing of cubicles and cubicle doors
2. Insulation Test
3. Light Load and functional test
4. Load characteristics test
5. Load duty test
6. Checking of auxiliary devices
7. Checking the properties of the control equipment
8. Checking the protective devices
9. Checking of control and functional requirements
10. High voltage test
11. Shaft current/ bearing insulation
12. Automatic restar/re acceleration

II. Type Tests

1. Allowable full load current versus speed
2. Efficiency
3. Temperature rise
4. EM immunity
5. EM emission
6. Current sharing
7. Voltage division
8. Line side current distortion content
9. Power factor
10. Audible noise
11. Torque pulsation
12. Motor vibration
13. Dynamic performance

14. Current limit and current loop test
15. Speed loop test capability to ride through voltages less than 80%
16. Test capability to restart the system and resynchronize converter onto running motor after a voltage interruption.

Type test certificate from independent testing agency for similar equipment can be accepted for 4,5,6,10,11,12.

C&I SPECIFICATION

FOR

SEWAGE TREATMENT PLANT

(RELAY BASED)

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SECTION -C

SPECIFIC TECHNICAL REQUIREMENT

Specific Technical Requirements (C&I):

1.0 The operation and control of Sewage Treatment Plant (STP) shall be done through **Relay based control system (Bidder's scope of supply).**
Relay based panel along with control desk shall be provided with coloured Mimic, H.W. Annunciator, Push Buttons., Indicators, indication Lamps and Ammeters.

2.0 The Bidder shall provide complete Instrumentation for control, monitoring and operation of entire Sewage Treatment Plant. The requirements given are to be read in conjunction with detailed Technical specification. Further in case of any discrepancy in the requirement within the same section 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 customer shall prevail without any commercial and time implication.

3.0 All KKS tag nos. shall have prefix 10.

4.0 The quantity of instruments for the system shall be as per tender P &ID wherever provided of the respective system as a 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 & items are required for safe & reliable operation of plant, bidder shall supply the same without any price implication. Instrument installation and required accessories shall be in bidder's scope.

5.0 **Redundancy of sensors shall be provided, irrespective of instrumentation shown in the PID, by bidder as per sheet attached in the specification. (ANNEXURE 1)**

6.0 Bidder shall furnish Instrument Schedule, Annunciation list, List of Instruments/devices in BHEL approved format. Also reusable database format like MS Excel, MS Access etc. of these documents shall also be provided by Bidder in BHEL approved format. Soft copy of the formats shall be provided to the successful bidder.

7.0 For cable scope refer to electrical scope between BHEL and vendor defined in electrical specification.

8.0 Bidder shall provide Cable Schedule in BHEL excel format which shall be provided during detailed engineering. Also, Cable engineering i.e Cable schedule, Cable Interconnections for Complete System shall be in Bidders' scope.

9.0 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, typical Hook-up diagram of drives is included for reference.

10.0 MOVs (Motorized Valves) shall be integral type, if applicable.

11.0 Bidder to furnish electrical load/UPS load data during detailed engineering.

12.0 240 V AC (supply feeder)/415 V, 3 phase, 4 wire AC supply shall be provided by BHEL based on the load data provided by the bidder at contract stage for all equipment supplied by the bidder as part of contract. Any other voltage level (AC/DC) required will be derived by the bidder. Bidder to include necessary power distribution board in his scope and all necessary hardware/software for the same shall be in bidder's scope.

13.0 Power supply derived for Transmitters, contact interrogation, interposing relay and solenoid shall generally be ungrounded 24V D.C only.

14.0 The solenoid operated valves/Dampers/Gate shall have a limit switch for open/close feedback. Solenoid Valve shall be rated for 24V DC only.

15.0 Bidder to supply all the instruments (PT,PG, LS, DPG, LG and DPS etc.) required for the package along with necessary fittings, accessories and valve manifold etc. All instruments shall be provided with durable epoxy coating for housing and all exposed surfaces of the instruments.
Instrument Installation along with hardware shall be in bidder scope.
Double root valves shall be provided where pressure is above 40 Kg/cm2.

16.0 All transmitters shall be smart type and shall have 4-20mA DC signal with superimposed digital communication (HART). Each Temperature

element shall be complemented with temperature transmitters, compensating cable, JB/rack & other erection hardware.

17.0 Use of process actuated switches shall be avoided unless Unavoidable.

18.0 All instruments and control elements shall be terminated on JB/LCP in field and both instrument and JB/LCP are in bidder scope. Number of Junction Boxes shall be sufficient and positioned in the field to minimize local cabling (max 12-15 mtrs) and trunk cable.

19.0 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.

20.0 DP instruments with minimum Capillary length of 15m is to be supplied.

21.0 All Temperature sensors shall be Duplex type and temperature transmitter shall be provided for all temperature measurement applications i.e Temperature transmitter (TT) shall be of dual input type. Head mounted Temperature transmitter is NOT acceptable. All TT shall be field mounted.

22.0 Instruments shall be provided alongwith Chemical seal/ diaphragm seal.

23.0 All field instruments enclosure shall be IP65 local panel/cabinet enclosure shall be IP 65.

24.0 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.

25.0 The junction boxes/LIEs for termination of instruments are in bidder’s scope.

26.0 The make/model of various instruments/items/systems shall be subject to approval of owner/purchaser during detailed engineering stage. No commercial/ time implication in this regard shall be acceptable. In case of any conflict or repetition of clauses in the specification, the more stringent requirements among them are to be complied with.

27.0 The make of all the items shall be from approved sub-vendor list.

28.0 Provision for separate Terminal block/wiring diagram for power and control blocks of control panel to be ensured.

29.0 All Instruments must have separate tapping lines. Sharing of the same tapping pipe for redundant instruments or various different instruments is not acceptable.

30.0 Electronic instruments shall not be located close to hot lines, vessels or other hot equipment. Ambient temperatures exceeding 80 °C shall not result in calibration difficulties or rapid deterioration of electronic components.

31.0 All the instruments/equipment/electrical items shall be provided & designed with maximum star rating in line with energy conservation policies as per latest international standards at the time of supply.

32.0 Bidder to note that all the transmitters/instruments supplied by Bidder shall be rack mounted. The racks shall be preassembled and provided by Bidder. Also no Instruments/ analysers & JBs/Racks should be protruding on the walkway.

33.0 All field instruments shall be terminated on Junction box/Local control panel in field. All the instruments along with necessary fittings, accessories and valve manifold etc., erection hardware including racks, junction boxes, canopies, structural steel, LIE, LIR, actuator limit switches etc.as required shall be in bidder's scope of supply.

34.0 Bidder to provide erection hardware including canopies, structural steel as required.

35.0 Bidder to perform tests of C&I items/instruments/systems as per quality plans/type test attached in the specification.

36.0 Every panel-mounted instrument, requiring power supply, shall be provided with a pair of 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.

37.0 Each valve/instrument shall be fitted with a stainless steel or aluminum nameplate indicating the valve/instrument service and reference number in accordance with the approved equipment coding system.

38.0 The design, manufacture, inspection, testing, site calibration and installation of all C&I equipment and systems covered under this specification shall conform to the latest editions of applicable codes and standards eg. ANSI, ASME, IEEE, ISO, IEC, IGCI, AWS, NFPA, AISC, IGS, SAMA, UBC, UL, NESC, NEMA, ISA, DIN, VDE, IS etc.

39.0 The specifications for instruments mentioned in the specification are minimum requirements. Datasheets of instrument shall be subject to customer/owner approval.

40.0 All approval/Inspection are to be carried out by Owner or owner appointed agency only.

41.0 Drawings/Documents and data to be furnished after award of the contract shall be in line with MDL furnished elsewhere in the specification.

42.0 Mandatory spare list as per 'List of mandatory spares' attached elsewhere in the specification is in bidder's scope.

43.0 Editable & pdf copy of Drawings/Documents and data to be furnished after award of the contract:

- GA & wiring diagram of local panel.
- Local control panel & instruments data sheet.
- Any other document decided during detailed engineering.

Note: -

1. All equipment items shall be of latest design with proven on track record from reputed experienced manufacturers of specified type and range of equipment. The make/model of various instruments/items/systems and instrument sub-vendor shall be subject to approval of BHEL/Customer during detailed engineering stage.

2. The above given scope is indicative & minimum. Any item/ equipment not indicated above however required for the completeness of the system is to be supplied by bidder without any technical, commercial and delivery implication to BHEL.

3. Documents of C&I System shall be submitted to end user/owner for approval during detail engineering. Changes, if any, shall be accommodated by the bidder without any price/time implication.

4. Uniformity of make and type of instruments and control components shall be

followed throughout for rationalization of spares' inventory, except for certain proprietary items where this requirement cannot be met.

5. In case of any discrepancy in Section-C and Section-D of the specification, Section-C shall prevail.

ANNEXURE - 1

(g) **Redundancy requirements**

i **Triple Redundancy**

Triple Sensing device shall be provided for following applications:-

a. **For** Binary and analog inputs required for protection of boiler , turbine and major auxiliaries of main plant whose non-availability may result in 50% loss of unit availability and loss of generation.

b. Binary and analog inputs, which are, required for protection of more than one equipment as well as protection signals for important auxiliaries and HT Drives of main plant (fed by a supply feeder of ratings 3.3 kV onwards)/MDBP/TDBFP etc.,

c. Separate triple sensors for Instruments required for auto starting of HT driven pumps or HT driven pump tripping due to very low level of water & discharge pressure very low.

d. For binary and analog inputs which are also required for protection in addition to CLCS. The same shall include but not limited to the critical measurement used for following CLCS :-

Furnace draft, main steam and reheat steam temperatures, feed-water flow, throttle pressure, turbine first stage pressure, separator level, LPH and HPH level, deaerator level, hotwell level, CEP minimum recirculation, BFP minimum recirculation etc.

e. For lube oil protection of all the HT drives, 2 out of 3 logics and necessary pressure transmitters for lube oil pressure shall be provided by bidder accordingly. However for bearing / winding temperature of HT motor, refer Electrical subsections, Vol. IV.

f. Left and right side shall be treated as individual path / individual parameter, and each side/path shall have own triple redundancy accordingly.

ii **Dual Redundancy**

Dual Sensing device shall be provided for following applications:

a. For binary and analog inputs required for all other closed loop control system (CLCS), protection and interlock conditions purpose of other equipments.

b. For Instruments required for auto starting of LT driven pumps or LT driven pump tripping due to very low level of water/discharge pressure very low.

c. Dual redundant position transmitters shall be provided for Steam Admission Valves i.e. (Emergency Stop & Control Valves, Reheat Stop Valves & Control valves), Extraction steam QCNRV, CRH NRV.

d. For instruments required for Heat rate measurements & PADO calculations.

iii. For binary and analog inputs used for alarm and monitoring only, single sensor criteria shall be applicable.

SECTION –D

INSTRUMENTS, JB & VALVES SPECIFICATIONS

CHAPTER-2: FIELD AND MEASURING INSTRUMENTS

2.00.00 MEASURING INSTRUMENTS (PRIMARY AND SECONDARY)

2.00.01 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/chapter 1, Vol. V, 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 Owner's approval.

2.00.02 Every panel-mounted instrument requiring power supply shall be provided with a pair of 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.

2.00.03 All transmitters, sensors, and switches, 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 Bidder shall furnish all Instrumentation / Control equipment & accessories under this specification as per technical specification, ranges, makes & model as approved by the Owner during detailed engineering.

2.00.04 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.

2.00.05 For corrosive applications, all instruments applications, they shall be provided with wetted parts made of Monel/ Hastelloy C or any other material (if proven ness experience of the proposed material for such applications is established by bidder).

All instruments shall be provided with durable epoxy coating for housings and all exposed surfaces of the instruments.

2.00.06 All field instruments shall be weatherproof, drip tight, dust tight and splash proof suitable for use under outdoor ambient conditions prevalent in the subject plant. All field-mounted instruments shall be mounted in suitable locations where maximum accessibility for maintenance is achieved. The enclosures of all electronic instruments shall conform to IP-65 unless otherwise specified (Explosion proof for NEC article 500, class 1/2, Division 1 area & Flame proof area) and an anti corrosive paint shall be applied to the field mounted enclosures / instruments.

In general, double cable entry shall be provided, wherever available, unused cable entry shall be provided with blind metal plug. All the field instruments shall also be provided with SS tag nameplate. Counter and mating flange (SS316 material), fastener, gaskets, Nuts, bolts etc. shall also be included wherever required with the field instruments.

2.00.07 In general, front draw out type instruments with plug-in facility at the rear for connecting cables for power supply and signal shall be provided unless otherwise specified like for Explosion proof area, Flame proof area and high vibration prone area. Separate plugs & socket connection shall be provided for connecting power supply cables and signal cables.

The plug & sockets shall be polarized to prevent wrong connections and have facility for secure coupling in plug-in position to prevent loose connections.

Signal and Electrical connection shall be screwed connection with double compression type Nickel-plated brass/SS316 cable glands (Material as decided by owner) for Explosion proof area, Flame proof area and high vibration prone area.

2.00.08 The quantity of secondary instruments etc. to be provided by Bidder shall be adequate to meet the requirements of Technical Specifications. Any other additional quantity of secondary instruments envisaged by Bidder as per system and process requirements shall also be supplied without any cost implication.

2.01.00 SPECIFICATION FOR ELECTRONIC TRANSMITTERS

2.01.01 SPECIFICATION FOR ELECTRONIC TRANSMITTER FOR PRESSURE, DIFF. PRESSURE AND DP BASED FLOW, LEVEL MEASUREMENTS

Sl. No.	Features	Essential/Minimum Requirements
1	Type of Transmitter	Microprocessor based 2 wire type, Hart protocol compatible
2	Accuracy	± 0.1% of calibrated span (minimum) (upto turn down ratio of 10:1).
3	Output signal range	4-20 mA DC (Analog) along with superimposed digital signal (based on HART protocol)
4	Turn down ratio	10:1 for vacuum/very low pressure applications. 5:1 for very high pressure application. 30:1 for other applications.
5	Stability	± 0.1% of calibrated span for six months for Ranges up to and including 70Kg/cm2. ± 0.25% of calibrated span for six months for Ranges more than 70Kg/cm2.
6	Zero and span drift	+/- 0.015% per deg.C at max span.

		+/- 0.011% per deg.C at min. span.
7	Load impedance	500 ohm (min.)
8	Housing	Weather proof as per IP-65 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 adjustability manual from instrument with zero suppression and elevation facility
13	Material	Die cast Aluminum with epoxy coating/SS316 for body. SS316 for Diaphragm.
14	Accessories	-Diaphragm seal, pulsation dampeners, syphon etc. as required by service and operating condition. - LCD/TFT digital integral Indicators with scale of Engg. Units. -2 valve SS316 manifold for absolute & Gauge pressure transmitters, 3-valve SS316 manifold for vacuum pressure transmitters & where DP transmitters are being used for pressure measurement and 5 valve SS316 manifold for DP/Level/Flow applicable. Transmitters should not be mounted directly on the manifold; Manifold shall be non integral type only. - Snubbers/Pulsation dampners shall be used where the process media is unstable for measurement such as the discharge of a pump. -For hazardous area, explosions proof enclosure as described in NEC article 500.
15	Diagnostics	Self Indicating feature
16	Power supply	24V DC ± 10%.
17	Adjustment/calibration From hand held calibrator/centralized OWS based system n/maintenance (as applicable).	From hand held calibrator/centralized OWS based system

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 Specification for Pressure Gauge, D.P Gauge, Temperature Gauge and Level Gauge

s. 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 SS 316	Mercury in Steel/Bimetallic type 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 Aluminum with stoved enamel black finish /SS316	Die Cast Aluminum with stoved enamel black finish /SS316	Forged carbon steel/SS 304
3	Dial Size	150 mm with toughened shatter proof glass	150 mm with toughened shatter proof glass	Tubular covering entire range
4	End Connection	½ inch NPT (M)	¾" NPT (M)	Process connection as per ASME PTC and drain/vent 15 NB
5	Accuracy	+/- 1% span	+/- 1% 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 be 1.5 to the max. Design pr. At 38°C		
9	Housing	Weather and dust proof as per IP-65	Weather and dust proof as per IP-65	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	SS316 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	SS 316	SS 316	

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 inert liquid suitable for the application.

2.03.00 GUIDED WAVE RADAR TYPE LEVEL TRANSMITTER

Guided wave radar type level transmitters shall be provided for level measurements of the vessel under vacuum or low pressure applications as specified in Part-A.	
Type	Guided wave Radar
Principle	TDR (Time domain reflectrometry)
Probe Type & Material	Coaxial, SS316/316L. If required, probe shall be suitable for overfill prevention.
Connection type and material	Flanged and SS316/316L.
Signal o/p	4-20mA with HART signal suitable for overfill prevention.
Display	Integral
Power supply	24 VDC

Accuracy	5mm
Electromagnetic compatibility	Shall meet EN 61326-1 (1997) and AmdtA1, class A equipment/EN 50081-2 & EN 5008 1-2 & EN 50082-2
Housing material	Die cast Aluminum/SS316.
Vent & Drain Plug material	SS 316
Local Display	LCD digital type, configured in engg. Units.
Accessories	Integral cable between sensor and transmitter unit with connectors on both side, gasket and cable gland, digital panel meter, name plate and metal tag. All material of accessories will be SS 316.
Mounting	External cage mounting
The transmitters shall be provided with IP-65 protection class with durable corrosion resistant coating. The transmitters shall be able to provide digital signals super imposed on 4-20 mA signal as per HART protocol.	

2.04.00 Ultrasonic Type level Transmitter

Sl.No.	Features	Essential/Minimum requirement
1.	Type of Transmitter	Non contact Microprocessor based 2 wire type, HART protocol compatible Ultrasonic transmitter. Also refer note-3.
2.	Output signal	4-20mA DC (Analog) along with superimposed digital signal (based on HART protocol)
3.	Sensor Accuracy	+/- 0.5% of calibrated span.
4.	Sensor Repeatability	3mm or better
5.	Power supply	24 V DC +/-10%
6.	Temperature compensation	To be provided within transducer
7.	Configuration	
8.	Housing	Weather proof as per IP-65 with durable corrosion resistant coating.
9.	Adjustment/Calibration/ maintenance	From hand held calibrators/ centralized OWS HART based system (as applicable)
10.	Zero and Span adjustment	Continuous, tamper proof, remote as well as manual adjustability from instrument. It shall be possible to calibrate the instrument without any level in the tank/sump etc.

11.	Sensor Material	Corrosion resistant material to suit individual application requirement.
12.	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
13.	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.
14.	Display	LCD display with integral keypad to be provided.
15.	Diagnostics	Loss of echo alarm etc.
16.	Load Impedance	500 ohms minimum.
17.	Electrical Connection	Plug and socket.
18.	Accessories	• All weather canopy for protection from direct sunlight and direct rain. • All mounting hardware and accessories required for erection and commissioning mounting fittings materials shall be SS 316. For hazardous area, explosion proof enclosure as described in NEC article 500.
Note:-	1) Bidder can also provide Radar type transmitter in place of ultrasonic transmitters subject to approval by Owner during detailed Engineer.	
	2) The frequency used for Ultrasonic /sonic measurements shall be suitable for envisaged applications and this shall be supported by the standard product catalogue of the instrument manufacture.	
	3) Four wire type transmitters can also be provided subject to Owner's approval during detailed engineering stage. However, in such cases isolated 4-20mA DC (analog) output shall be provided. Power supply required for such transmitters shall be 24V DC for main plant and CW system applications. Power supply can be 240V AC (UPS) / 24V DC for other application.	

	4) Additional separate local display unit with large Alphanumeric back light LCD/LED & to be provided for the applications which will be decided by owner during detailed engineering. Separate Sensor unit & electronics unit with LCD display to be provided for the applications, which will be decided during detailed engineering by owner.

2.05.00 HART Hand Held calibrator

Hand held calibrator shall be provided for adjustment/calibration/maintenance of the HART compatible transmitters. The hand held calibrator shall be suitable for all types of transmitters supplied in the package. If one type of hand held type calibrator is not suitable for communicating with all types of transmitters then separate hand held calibrator will be provided.

HART hand held calibrator shall be provided with following minimum accessories per set:-

i. Soft carrying case with adjustable shoulder straps & lead compartments.
ii. HART lead set.
iii. Rechargeable batteries.
iv. Battery charger.
v. Power adaptor.
vi. Universal plug kit for power adaptor.
vii. Load resistor.
viii. Interfacing cables of each type as per requirements.
ix. Protective boot.
x. Standard banana jack.
xi. Operation manual & software CD.

The quantity of HART hand held calibrator to be provided by Bidder is listed in Appendix- I to Vol.V, Table IV, Part A of Technical Specifications.

2.06.00 Temperature Elements and accessories

2.06.01 Thermocouples

S.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 S/R) depending on operating temperature Range (ungrounded type).
2.	No. of element	Duplex
3.	Housing/Head	IP-65/Die cast Aluminum. Head of TE to be provided with sufficient space and arrangement to head

		mounted temperature transmitter (as applicable). Plug in connectors are to be provided for external signal cable connection.
4.	Sheathing of Thermocouple	Swaged type magnesium oxide insulation
5.	Calibration and accuracy	As per IEC-751/ANSI-C-96.1(special class) for T/C
6.	Characteristic	Linear with respect to temp, within ±1/2 percent of top range value
7.	Accessories	Thermo well (as specified below) and shall be spring loaded for positive contacts with the well.
8.	Standard	ANSI C 96.1 for Thermocouple and ASME PTC-19.3 (latest edition) for Thermo-well.
9.	Sheath Material/ Insulation	316SS/Compacted Magnesium Oxide.
	Sheath O D	8 mm.
10.	Response Time	6-10 Sec bare & 30 Sec. With protective sheath/thermowell
11.	Instrument Connection	1/2 " NPT (F).
12.	Electrical connection	Gold plated Plug in type. Double entry, one unused entry with blind plug.
13.	Enclosure Class	IP-65 or better.
14.	Process Connection	i) M33 x 2 ii) Flanged for Air & Gas systems with mating flanges, fastner, gasket etc.
15.	Extension	Threaded union (SS316) 1/2" NPT (F) with two nipples of SS 316 having 1/2"NPT(M) threads at both ends
16.	Extension neck length	Minimum 100 mm above Insulation of pipe and Minimum 160 mm when there is no insulation on pipe.

Notes

1. Extension cable exposed to atmosphere in the conventional method melts away due to high temperature at the top of mill or due to coal burning. Hence The terminals of temperature sensors shall not be at the top of mills

itself. The temperature sensors wires are to be laid up to JB though SS tube of required diameter and the head shall be placed nearer to the JB.

2. Thermocouples provided for steam services like super heater / de super heater area, where the process pipe is inside the insulation of boiler penthouse, Thermowells are inaccessible and terminal head and connecting cable cannot withstand high temperature, for such services thermocouples shall be provided with flexible extension SS316 Sheath of 10-15 meters.
3. The specification for thermocouples of bearings metal and winding 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.

2.06.02 Resistance Temperature Detector (RTD)

S.No.	Features	Essential/Minimum Requirements
1.	Type of RTD	Four /Three wire, Pt-100 (100 Ohms resistance at zero degree Centigrade).
2.	No. of element	Duplex
3.	Housing/Head	IP-65/Diecast Aluminum. 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.
4.	Sheathing of RTD	Metal sheathed, ceramic packed
5.	Calibration and accuracy	As per DIN-43760/IEC 60751 Class-A for RTD
6.	Characteristic	Linear with respect to temp, within ±1/2 percent of top range value.
7.	Accessories	Thermo well (as specified below) and shall be spring loaded for positive contacts with the well
8.	Standard	DIN-43760/IEC 60751 for RTD and ASME PTC-19.3 (latest edition) for Thermo-well.
9.	Sheath Material/ Insulation	316SS/Compacted Magnesium Oxide.

	Sheath O D	8 mm.
	Gauge	18 SWG
10.	Response Time	6-10 Sec bare & 30 Sec. With protective sheath/thermowell
11.	Instrument Connection	1/2 " NPT (F).
12.	Electrical connection	Gold plated Plug in type. Double entry, one unused entry with blind plug.
13.	Enclosure Class	IP-65 or better.
14.	Process Connection	i) M33 x 2 ii) Flanged for Air & Gas systems with mating flanges, fastner, gasket etc.
15.	Extension	Threaded union (SS316) 1/2" NPT (F) with two nipples of SS 316 having 1/2"NPT(M) threads at both ends
16.	Extension neck length	Minimum 100 mm above Insulation of pipe and Minimum 160 mm when there is no insulation on pipe.

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.

2.06.03 Metal Temperature Thermocouples

S.No.	Features	Essential/Minimum Requirements
1.	Measuring Medium	Metal Temperature
2.	Material of Thermocouple	Chromel Alumel Type K
3.	Type of Thermocouple	Duplex with separate hot junctions, ungrounded Insulation Mineral Insulation Magnesium Oxide.
4.	Thermocouple wire gauge	16 AWG
5.	Protective sheath	SS 321
6.	Protective sheath dia	8 mm O.D
7.	Characteristics of Thermocouple	Special limits of error as in ANSI thermocouple MC 96.01, 1975
8.	Mounting accessories	1/2" BSP SS sliding end connector, weld pad, clamps of heat resistant steel SS310

		or as per OEM design
9.	Cold end sealing	SS pot weal with colour coded PTFE headed sleeve Insulated flexible tails. Sealing compound- Epoxy resin
10.	Minimum bending radius	30 mm
11.	Length of T/C	30 Mtr. (minimum)

Notes:

1) The specification for thermocouples of bearings metal and winding 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 installation and response time, manufacturers standard and proven specification for metal temperature measurement can also be a accepted subject to OWNER approval. The manufactures shall submit adequate supporting documents for establishing their standard and proven practice.

2.06.04 Thermo well (for all process temp. elements) - (As per ASME PTC 19.3, latest edition)

a. Shall be one piece solid bored type of 316 SS/F11/F22/F91 of step-less tapered design for water and steam Services depending upon process parameters.

b. For Mill classifier outlet long life solid sintered tungsten carbide material of high abrasion resistance shall be provided.

c. For Air & Flue gas 316 SS protecting tube with welded cap. (However bidder shall provide better material for Flue gas service if required based on the specified boiler design parameters).

d. For furnace zone, impervious ceramic protecting tube of suitable material along with Incoloy supporting tubes and adjustable flanges.

e. Bidder shall provide calculation for thermowell as per ASME – PTC-19.3 (latest edition).

"All Thermowells in high velocity steam service shall be checked for Strouhal's frequency limit to arrive at a safer size and design of Thermowells".

2.06.04 Void

2.06.05 TEST THERMOWELLS (TW)

Applicable Standard	:	ASME PTC 19.3 TW - 2010
Type/Construction	:	Machined from Bar Stock
Material	:	316 SS/F11/F22/F91
Connection		
- Pipe	:	M33 x 2
- Test Instrument	:	To suit test instruments
Accessories	:	Plug with SS chain
IBR Certification	:	For high pressure service, Steam Temp., Fuel oil temp. measurement as per IBR rules and regulations Bidder shall provide calculation for thermowell as per ASME – PTC-19.3 TW - 2010.

Test wells shall be provided on main steam, reheat steam, extraction steam, feed water, condensate, spray water lines and other piping as required to meet ASME test requirements.

2.07.00 TEMPERATURE TRANSMITTER

Following types of 2-wire 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 bidder as well as Owner. 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. The protection class of head of thermo well along with its plug-in connector shall be min. IP65.

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 Indicator:**

These shall be suitable for mounting on pipes/ support. 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.

The exact applications for which this type of transmitter is to be provided shall be finalized by owner during detailed engineering.

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	:	Compatible with input module of Control System
Accessories	:	Mounting arrangements including Clamps etc.
Composite Accuracy type	:	(a) For head mounted and DIN-rail mounted 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

(b) 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

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 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.

Notes (Common for a to e 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.

2.08.00 IMPACT HEAD TYPE FLOW ELEMENT

The impact head type element shall be tubular insert type with four impact ports facing upstream direction, located precisely for determination of average flow velocity and shall be of SS 316 L.

Accuracy shall be 1.0% of actual value or better. Repeatability shall be $\pm$ 0.1% of actual value or better.

The elements shall be supplied complete with mounting hardware; end support plugs and SS316 valve manifold (1/2" NPT connection) for instrument connections. All pertinent data including Owner's instrument tag no. for the flow element shall be punched on a stainless steel plate and affixed to the element.

Flushing arrangement shall be provided.

Dual path transit time clamp-on Ultrasonic Flow meter may also be used for measurement of CW flow.

Each analyser shall be independent and shall not share power supply, processor etc. with other analyser except compressor for purging air.

The common requirements to be met for all types of analysers are as below. The specific requirements to be met by each type of analyser are detailed in the subsequent clauses.

2.09.01 Common Requirements for all Analysers:-

S.No.	Features	Essential/Minimum Requirements
1	Output signals	
	Analog	4-20 mA DC galvanically isolated. If analyser provides superimposed HART signal on 4-20 mA DC output, It shall also be connected to OWS/PC based station.
	Binary	2 NO + 2 NC for high alarm
2	Zero & span Adjustment	To be provided with range selection facility.
3	Ambient temp.	50°C
4	Indication	Digital Alphanumeric Display. Display of reading in engineering units shall be provided.
5	Enclosure Type/Material	Weather & Dust proof (IP 65) Die cast Aluminium/SS.
6	Type of Electronics	Microprocessor based with self diagnostic.
7	Digital Signal transmission	HART/RS 485 Port Modbus Protocol/Ethernet TCP/IP protocol.
8	Calibration	Auto & Manual (from Remote)
9	Power Supply	To be arranged by Bidder subject to Owner's approval.
10.	Others	I) All interconnection tubing and cabling between probe and analyser / analyser panel and cabling from analyser/ analyser panel to DDCMIS (in central control room) & OWS/PC station are to be provided by Bidder.
		ii) All the calibration gases required for one year continuous operation shall be provided. The calibration gas container material shall not contaminate the calibration gas.
11	Location of probe	High temp O2 –SH zone Low temp O2:- ECO outlet, AH outlet and ID inlet. Dust emission analyser – In each ESP gas stream/path
12	Compliance to standards	USEPA, TUV, MCERTS or equivalent standards
13	Type of Technology	Dust emission analyser – Opacity In situ (Path)type/ Tribo Electric Induction method In situ type

		Low temp O2 & High temp O2-Insitu type

2.09.02 Low temp O2 and High temp O2 Analyser cum monitor:-

Specification Requirements system	**Oxygen Analyser cum Monitor (High Temp.)**	**Low temperature O2 Analyser cum monitor**
Type of instrument	Non-heated in-situ dry type	Heated type in-situ
Principle of Measurement	Partial-pressure using Zirconium Oxide Cell	Partial-pressure using zirconium oxide cell
Measurement Range	0.01% to 10% oxygen	0 to 25% oxygen programmable up to min 0.5% of O_2
Accuracy	+/-1% of F.S. or 0.5 % O_2, whichever is more	+/-1% of Full Scale
Linearity	$\pm$ 1% of F.S.	$\pm$ 1% of F.S.
Repeatability	$\leq$ 0.5% of span	$\leq$ 0.5% of span
Response time(up to 90% of full scale)	$\leq$ 5 secs	$\leq$ 5 secs
a) Temperature Drift	-	-
b) Zero Drift	-	< 1% span/week
c) Span Drift	Stability:- 1% deviation throughout life of sensor	< 1% measured value/week
Operating Temperature Range	600-1600 deg. C	0-450 deg. C
Filter	Cell shall be protected using ceramic boot	Suitable filter to be provided
Accessories purging system	Not applicable	Not applicable
Temperature	Yes With R/B type thermocouples (to be finalised during detailed Engineering) required.	Automatic temperature control of heating circuit through thermostat

Note: 01. For O2 Analyzer, the construction of the sensor shall be such that joints between dissimilar materials are avoided to prevent formation of cracks.

(c) Air supply line to pneumatic interlocked block valves.
(d) For each instrument rack, field instruments enclosure for purging.

2.11.02 E-P CONVERTER

E-P converters and associated accessories shall be furnished in accordance with the specifications given below:

Air supply: 1.5 kg/cm sq., Input signal: 4-20m A dc (as required by the design of control system), Output signal: 0.2 to 1.0 kg/cm sq., Linearity: 0.5% of span or better, Hysteresis:0.5% of span or better, Ambient Temperature Effect: less than 0.02% of span per deg C between -20 to +60 deg C. Mounting: Close to actuator (but not on the actuator), output capacity-to suit the actuator, protection class IP 65. On loss of control signal, the last set point pressure shall be maintained so that the associated control valve remains in stay put condition without any additional solenoid valve. The allowable drift rate will be +2% of set point/ hour maximum. Material of accessories will be SS. E/P convertors shall have fail freeze (stay put) feature also. Zero/span adjustment facility shall be provided.

2.12.00 SPECIFICATION FOR FLOW ELEMENTS & FLOW METERS

2.12.01 Orifice Plate

Sr No.	Features	Essential/Minimum Requirements
1	Features	Essential/Minimum Requirements
2	Type	Concentric as per ASME PTC-19.5 (Part-II), ISA RP- 3.2, 1960 or BS-1042, ISO 5167
3	Material	316 SS
4	Thickness	3 mm for main pipe diameter up to 300 mm and6 mm for main pipe dia above300 mm.
5	Material of branch pipe	Same as main pipe
6	Root valve type	Globe
7	Root valve material	316 SS
8	Root valve size	1 / 2 inch or 1 inch (as applicable)
9	Impulse pipe of same material up to root valve	Required
10	Tapping	Flanged weld neck or D & D/2 with 3 pairs of tapping (as applicable). Root valves to be provided in all the tappings.
11	Beta Ratio	0.34 to 0.7
12	Beta Ratio	Yes

	calculation to be submitted	
13	Assembly drg. and flow Vs DP Curves	Yes
14	Accessories	Root valves, flanges, Vent/drain hole (As required)
Bidder shall submit certified flow calculation and differential pressure vs. flow curves for each element for Owner's approval. Sizing calculation, precise flow calculation for all the flow elements, fabrication and assembly drawings and installation drawings shall be submitted for Owner's approval. One Flow element of each type shall be calibrated in the test laboratory for validation of commutated flow calculations		

2.12.02 Flow Nozzle

Sr No.	Features	Essential/Minimum Requirements
1.	Type	Long radius, welded type as per ASME PTC- 19.5 (Part-III) or BS-1042
2	Material	316 SS
3	Thickness	Suitable for intended application.
4	Material of branch pipe	Same as main pipe
5	Root valve type	Globe
6	Root valve material	316 SS
7	Root valve size	1 inch
8	Impulse pipe of same material up to root valve	Required
9	Tappings	Flanged weld neck or D & D/2 with 3 pairs of tapping (as applicable).
10	Beta Ratio	Around 0.7
11	Beta Ratio calculation to be submitted	Yes
12	Assembly drg. and flow Vs DP Curves	Yes
13	Accessories	Root valves, vent and drain hole.
Bidder shall submit certified flow calculation and differential pressure vs. flow curves for each element for Owner's approval. Sizing calculation, precise flow calculation for all the flow elements, fabrication and assembly drawings and installation drawings shall be submitted for Owner's approval. One Flow element of each type shall be calibrated in the test laboratory for validation of commutated flow calculations		

2.12.03 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-65
8	Accuracy	$\pm$ 2% of measured value

2.12.04 POSITIVE DISPLACEMENT TYPE FLOW TRANSMITTERS

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. Air eliminators shall also be provided to ensure maximum accuracy.

The measurement accuracy of the transmitter shall be better than $\pm$ 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 Owner's approval during detailed engineering without any price repercussion to Owner.

2.13.00 PROCESS ACTUATED SWITCHES

Sr No.	Features	Essential/Minimum Requirements		
		Pressure/Draft Switches/ DP Switches	**Temperature switches**	**Level switches**
1	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 (10 m minimum)	Capacitance types for oil and dirty medium, water, condensate application. Float type for applications as

				decided by owner during detailed engineering. Capacitance/Conductivity/Ultrasonic type for acid and alkali application. RF/ Ultrasonic type for ash hopper, ash slurry application. Detailed spec are also included below.
2	Material of sensing element & movement.	316 SS	Bulb 316 SS/ capillary 304 SS	316 SS
3	End connection	½ inch NPT (F)	½ inch NPT (F)	Manufacturer standard
4	Over range proof pressure	150% of max. design pr	-	150% of max. design pressure
5	Repeatability	± 0.5% of full range		
6	No. of contacts	2 Nos. +2NC. SPDT snap action dry contact. Auto reset with internal Adjustable snap action micro switch.		
7	Rating of contacts	60 V DC, 6 VA (or more if required by DDCMIS/PLC)		
8	Elect. Connection	Plug in socket		
9	Set point	Provided over full range. Differential shall be adjustable.		
10	Dead band adjustment	Adjustment upto 10% at set points.		
11	Enclosure	Die cast Aluminum with stoved enamel black finish/SS316, Weather and dust proof as per IP-65. Epoxy painting shall be provided for corrosive atmosphere.		
12	Accessories	Siphon, snubber, chemical, pulsation dampers as required by process.	Thermo well of 316 SS and packing glands	All mounting accessories
13	Mounting	Suitable for enclosure/rack mounting or direct mounting	Suitable for rack mounting or direct mounting	-
14	Power Supply (whereever	24 V DC, to be arranged by Bidder except for Ash Level Switches, where the same shall be as per Bidder's Standard practice.		

	Required)	

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 pressure / DP measurements can have sensor material other than SS316 e.g. silicon etc., if the offered material is suitable for that application and the offered product is standard product of the manufacturer 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.

2.13.01 Conductivity Type Level Switch

Type	:	Conductivity discrimination.
Mounting	:	Flanged – on standpipe.
Probe MOC	:	Stainless steel with high purity ceramic.
Probe rating	:	> Maximum design pressure of vessel.
Input	:	Four independent channel with selectable switching threshold for water conductivity.
Relay Output	:	Four isolated output relays for Hi, Lo, Hi-Hi, Lo-Lo.
Contact type & rating	:	2SPDT or 1 DPDT @ 5A 30V DC.
Faults Detection	:	Power Fail/Electrode Connection Open circuit/short circuit to ground, Ground failure. In built Fail Safe Logic.
Indicator	:	One Red LED for steam/ one Green LED for water/ Two no. LED one each for Process & system fault.
Power supply	:	Dual 230V AC, 50 Hz, 1Ph from UPS.

	Enclosure	:	Corrosion resistant & wall mounting type. IP-65 or better (Explosion proof For NEC Class-1/2, Division 1 area)/ flame proof (IEC-79.1, Part I). As applicable).
	Accessories	:	i. PTFE cable from probe to electronics unit. Electronic unit shall be separate. Head mounted electronic unit is not preferred. ii. Mounting accessories iii. standpipe iv. Washer & gasket
	Test pressure	:	Two times rated pressure

2.13.02 Capacitance Type Level Switch

	Type	:	Capacitance type
	Probe	:	a) Rod or suspended electrode b) Rope type probes may be used only where required probe length is greater than 3 meters.
	Probe Mounting	:	Stainless steel 1-1/2 ANSI RF Flange / ¾" NPT (M)
	Material of construction	:	316 SS
	Insulation	:	PTFE Part/Full as per service.
	Enclosure	:	Powder/Epoxy coated Die cast Aluminum. with neoprene gasket conforming to IP-65. (Explosion proof for NEC Class-1/2, Division 1 area)/ flame proof (IEC-79.1, Part I). As applicable).
	Ambient temperature	:	0-60 ºC.
	Mounting	:	On Top
	Supply voltage	:	230V AC, 50Hz from UPS / 24V DC
	Relay output	:	2SPDT
	Contact rating	:	5A min. at 240V AC on resistive load
	Response time	:	100 m sec or better
	Cable connection	:	Plug in type

Accessories	:	Counter flange, Cable gland, prefab cable and stainless steel name plate engraved with alpha-numeric.

2.13.03 RF TYPE LEVEL SWITCH

A. Electronic Controller

1.	Input Supply	:	230 V AC from UPS
2.	Construction	:	Cast Aluminum Housing
3.	Relay Output	:	2 Nos. Relay Changeover Potential Free Contacts (2 SPDT)
4.	Contact Rating	:	5A at 240 V AC & 0.25 at 220 V DC
5.	Class of Protection	:	IP-66
6.	Ambient Temperature	:	55 Deg. C (Max)
7.	Local Indication	:	Local LED Indications
	Green	:	Normal Level
	Red	:	Alarm Level
	Yellow	:	Probe Healthy
8.	Cable Connection	:	3/4" ET (2 Nos.) for Supply and Output 5/8" ET (1 No.) for Probe Connection
9.	Repeatability	:	100%

B. Sensing Probe

1.	Type of Probe	:	Rigid
2.	Material	:	Stainless steel SS 316
3.	Probe Head Housing	:	Cast Aluminum
4.	Insulation (B/W Active & Shield And Shield & Ground)	:	PTFE
5.	Probe Head Protection	:	IP-66
6.	Mounting	:	Side Mounted
7.	Cable Connection	:	5/8" ET (1No.)
8.	Process Connection	:	40 NB BSP THREADED

C.	Signal Cable	:	Coaxial cable for Connection Between Sensing probe and electronic Controller (@ 10 Mtrs. Per Level Probe)
D.	Application	:	Silos

2.14.00 SOLENOID VALVES

Solenoid valves shall fulfill the following requirements:

a. Type 2/3/4 way with body material of SS 316/Forged Brass and epoxy painting (depending on the application subject to Owner's approval during detailed Engg.). Material of Wetted parts shall be SS316.

b. Power supply 24 V DC + 10%.

c. Plug and socket electrical connection.

d. Insulation: Class 'H'.

e. All solenoid shall be with, LED indication, surge suppression diode circuits.

2.15.00 Power Cylinders (Pneumatic)

Mounting Type	:	a) Fixed position mounting (End mounting). : b) Trunnion mounting
Control Signal	:	0.2 to 1 Kg/Sq. cm. from I/P converter for modulating purposes. 24V/48VDC operated solenoid valve operating on pneumatic line. The Pilot solenoid will have separate coils for open closing purpose.
Supply Air	:	0-7 Kg / Cm2.
Selection	:	Based upon thrust / torque, stroke length, angular movement, full-scale travel time, repeatability, space factor etc. Provision for air-to-open and air-to-close operation.
Casing	:	IP-65.
Accessories (as required)	:	a) Air lock relay b) Hand wheel. c) Air filter regulator with gauge. d) Volume Booster. e) Limit Switches. f) Positioner with Input, Output and supply pressure gauges. g) Pilot Solenoid Valve (Double Coil type) h) Position Transmitter (4-20 mA DC linear output, LVDT or non contact type).
Fail-safe operation	:	Stay put, open or close position on pneumatic / electrical power supply failure as per process safety criteria.
Repeatability	:	Better than 0.5% of full travel.

UPS

2.16.08 FLOAT & BOARD TYPE LEVEL GAUGE

Type of Instrument	:	Mechanical Type (Float Operated)
Service/ Application	:	As per service requirement
Measuring Range	:	As per requirement
Material Specification		
a) Float Material	:	SS316 having 2 nos. Guide wires
b) Float Wire Pulley	:	Shall comprise of 2 nos. Cast Aluminum Pulley hosing Assembly with SS 304 pulley and pulley shaft. Steel ball bearings shall be provided in pulley housing for easier float movement. Float wire material shall be SS316L. Between 2 pulleys, 1" NB G.I. short pipe.
c) Guide wire Assembly	:	CS chamber with spring and adjuster having 1" Class 150 ANSI RF MS flange. Guide wire rope shall be SS316L.
d) Counter Weight	:	MS counter – weight with Aluminum Pointer and Brass assembly Pull Chain.
e) Scale details	:	Aluminum/SS316 scale Graduated in mm with 1% accuracy of full scale range with arrow.
Nozzle Details	:	For float wire pulley assembly, one tapping and for guide wire assembly two tapping at the top of the tank; Size 1" NB (Top Mounting Type).
Process Connection	:	Flanged as per ANSI B 16.5 to suit 1" NB nozzle (Nozzle length - 150 mm for float wire, 100 mm for guide wire)

Accessories (to be supplied with the instrument)

a) Counter flange	:	All mating Flanges, Nozzle
b) Mounting Accessories	:	All mounting accessories
c) Tag Plate	:	To be provided (material SS316)

2.18.00 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 65. Contact shall be either 1 no, DPDT or 2 nos. SPDT minimum.

For main plant application, limit switches are to be provided as per bidder standard and proven practice.

All limit switch shall be conform to IEC-60947-5-1.

2.23.21 POWER FACTOR METER (DIGITAL)

Type	:	Electronic digital 7- segment with fluorescent display
Input	:	4 - 20 mA DC
Mounting	:	Flush Panel, compatible for mounting on mosaic grid panel
Number of digits	:	41/2 digit
Face Dimension	:	192X192 mm
Digit size	:	Approximately 40 mm
Range	:	- 1 - 0 - + 1
Accuracy	:	± 0.25 %
Display	:	Red LED display
Connection	:	Plug in type
Magnetic Shield	:	Shielded Case

2.23.22 SYNCHROSCOPE

Synchroscope shall be designed to provide an illuminate and indication of phase and frequency difference between bus voltages and generator voltage. It shall denote the actual frequency difference corresponding to the inverse of time taken for one rotation of the illuminated vector spot. Synchroscope shall be designed as per IEC/DIN/BS standard.

Input	:	Differential frequency & Differential Voltage
Mounting	:	Flush Panel, compatible for mounting on mosaic grid panel
Face Dimension	:	96 x 96 mm
Accuracy	:	± 0.5%
Magnetic Shield	:	Shielded Case

2.24.00 CONTROL DESK/PANEL PUSH BUTTONS

2.24.01 PB/ ILPBs FOR ON/OFF, OPEN/CLOSE

Type	:	Momentary/Miniaturized Suitable for mosaic grid 24x48 Mm with 2 PB and 3 coloured LED.
Contact Configuration	:	2 NO + 2 NC
Contact Material	:	Hard Silver Alloy
Contact Rating	:	500V / 10 A
Insulation Voltage	:	2 KV for 1 minute between terminals and earth
Lamp Rating :- a) Voltage	:	240 V AC

b)	Watt	:	2 Watt (approx.)
Colour			
Red		:	ON/Start/Open ILPB
Green		:	OFF/Stop/Close ILPB
Red		:	energized, running, Start, valve open LED/Lamp
Green		:	de-energized, stopped, valve closed LED/Lamp
Light yellow		:	abnormal, discrepancy LED/Lamp
Red		:	OFF/Stop/Close PB
Green		:	ON/Start/Open PB
Red		:	Emergency trip push buttons with red flap / Hinged Transparent acrylic cover.

2.24.02 PUSH BUTTON FOR Control DESK

Type	:	Momentary mosaic grid mounted 24x48 mm size, single PB 18x40 mm
Colours		
DESK RELEASE PB		- Yellow
Desk Lamp test PB		- Blue
Desk Acknowledge PB		- Green

2.24.03 PUSH BUTTON FOR SEQUENCE START/RELEASE

Momentary (Miniaturised) suitable for mosaic grid 24x48 mm, 3 PB + 5 LED.

2.24.04 PUSH BUTTON FOR ANNUNCIATION

Contacts		
- Number & Type	:	As per requirement
- Breaking capacity	:	1 Amp, 220V DC 10 Amp, 600V AC Different colours for Accept/Acknowledge - Green, reset Grey, test – Yellow & Audio Acknowledge – Black.

2.25.00 Digital Indicators for Control Desk Draw out section.

Type	:	Electronic digital 7- segment with fluorescent display
Input	:	4 - 20 mA DC
Mounting	:	Flush Panel
Number of digits	:	31/2 digit, Float decimal.
Size	:	48 mm (W) x 24 mm (h)/50 mm x 25 mm
Accuracy	:	2.5% of final value
Display	:	Red LED display
Temp. coefficient	:	0.15%/deg C of measured value

Interface Units, Surge suppressors, Opto isolators, Interface Converters, Fibre Optic Card Cage, Fibre Optic Line Driver, Repeater / Modem (for Optical Fibre Cables), cable glands, grommets, lugs, termination kits etc. on as required basis.

9.07.02 Cables, which terminate in cabinets of draw out sections shall have sufficient cable coiled in the bottom of the cabinet to permit full withdrawal of draw out sections without disconnecting the cables. When prefabricated cables with factory connectors on both ends are longer than required, the excess cable shall be coiled in the bottom of one or both termination cabinets.

9.07.05 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.

9.07.06 The Bidder 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 Bidder.

9.08.00 Field Mounted Local Junction Boxes

Type of Enclosure	:	Flame proof/weather proof IP-65 /Explosion Proof as per area classification. Design as per NEC-370 Article 18, 19 & 20.
No. of Ways	:	12/24/36/48/64/72/96/128 with 20% spares terminals.
Material	:	4 mm min. thick FRP (Fiberglass Reinforced Polyester) with protective Coating 3 mm min. thickness Die cast aluminum for Flame proof/Explosion proof area.
Cable entry	:	Bottom or Side
Cable glands	:	Double compression type – Nickel plated Brass/SS316 with PVC hoods.
Mounting	:	Indoor/Outdoor
No. of terminals	:	As required with standardization with 20% spare of each size & type.
Terminals	:	Phoenix/Wago (screw less rail mounted cage clamp type spring loaded suitable for conductor size up to 2.5 sq. mm)
Grounding	:	Two terminals for body and shield ground
Door	:	Hinged, lockable type.
Accessories	:	Suitable mounting clamps and other accessories shall be in scope of bidder. The brackets, bolts, nuts, screws, glands, lugs required for erection shall be of SS304, included in bidder scope of supply. High voltage & insulation resistance test shall also be conducted.

M6 Ni plated Brass earthing stud shall be provided (external 2 nos. internal 1 no.)
Gasket (Normal)- Neoprene/Polyurethene thickness 6.0 mm. Silicon for high Temp. area.

Colour : To be decided during detailed engineering & subject to owner's approval.

9.09.00 Conduits

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 galvanised 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 application, water leak, fire and rust proof flexible GI conduits shall be provided. The temperature rating of flexible conduit shall be suitable for actual application.

The Bidder shall install conduits according to the general routing as approved by owner and shall coordinate conduit locations with other works.

All grounding bushings within all enclosures shall be wired together and connected internally to the enclosure grounding lug or grounding bus with 8 AWG bare copper conductors. Conduit runs to individually mounted equipment shall be grounded to the Owner's cable tray grounding conductor with 12 AWG bare copper conductor. All grounding bushing, clamps, and connectors shall be subject to approval of the owner.

All rigid conduit fittings shall conform to the requirements of IS: 2667, 1976. Galvanised steel fittings shall be used with steel conduits. All flexible conduit fittings shall be liquid tight, galvanised steel. The end fittings shall be compatible with flexible conduit supplied.

All individually mounted equipment and devices shall be connected to the supply conduit, using not more than one meter of flexible conduit adjacent to the equipment or device. Flexible conduit shall be installed in all conduit runs, which are supported by both building steel and structures subject to vibration or thermal expansion. This shall include locations where conduit supported by building steel enters or becomes supported by the turbine generator foundation and where conduit supported by building steel or foundation becomes supported by steam generator framing.

Special areas, such as control rooms in which external noise is to be minimized, shall have flexible conduit in conduit runs where the runs cross from the main Building framing to the control room framing.

BHEL	**SPECIFICATION FOR MOTORISED VALVE ACTUATOR**	SPECIFICATION NO.:
		VOLUME II B
		SECTION D
		REV. NO. 00 DATE: 26.02.18
		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	1 x 6600 MW PANKI Thermal Power Project	
	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 -20 to70 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,DUST TIGHT SUITABLE FOR OUTDOOR USE WITHOUT CANOPY, NEMA6/IP:68	
	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 REGULATING SERVICE - 150 STARTS/HR MINIMUM OR REQUIRED CYCLES WHICHEVER IS HIGHER..**	
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	■ RAL 7032	
	PAINT TYPE (**Refer Notes)**	☐ ENAMEL ■ EPOXY ☐ …….	
	SHAFT RPM	BIDDER TO SPECIFY	
	OLR SET VALUE	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%, 3 Phase, 3 Wire 50HZ +/-5%	
	@ CONTROL VOLTAGE REQUIREMENT	TO BE DERIVED FROM THE POWER SUPPLY TO THE STARTER ☐ 230 V ■ 110 V	

BHEL	**SPECIFICATION FOR MOTORISED VALVE ACTUATOR**	SPECIFICATION NO.:
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Data Sheet A & B

DATA SHEET-A (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)

	@ ENCLOSURE CLASS OF MOTOR	☐ IP 67 ☐ FLAME PROOF	
	@ 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(Reversing type) ☐ THYRISTORS	
	TYPE	■ CONVENTIONAL ☐ SMART (NON-INTRUSIVE)	
	IF SMART		
	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-STOP-CLOSE PB(running open/close LED) THREE POSITION SELECTOR SWITCH	■ REQUIRED ☐ NOT REQUIRED	
	INDICATING LAMPS	■REQUIRED ☐ NOT REQUIRED	
	LOCAL-OFF- REMOTE S/S(THREE POSITION SELECTOR SWITCH)	■REQUIRED ☐ NOT REQUIRED	
	STATUS CONTACTS FOR MONITORING	■ REQUIRED ☐ NOT REQUIRED	
	INTEGRAL STARTER DISTURBED SIGNAL	REQUIRED (MOTOR THERMOSTAT TRIPO/L RELAY OPERATED, CONT. /POWER SUPPLY FAILED, S/S IN LOCAL/OFF MODE, TORQUE SWITCH OPEN/CLOSE CUT OFF/STOP PB OPTD.)	
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) **($$ Refer Notes)**	MFR & MODEL NO.	BIDDER TO SPECIFY	
	OPEN / CLOSE	☐1 No. ■ 2Nos. / ☐1 No. ■2Nos	
	CONTACT TYPE	2 NO + 2 NC	
	RATING	5A 250V AC AND 0.5A 220V DC	
	CALIBRATED KNOBS(OPEN&CLOSE TS)	REQUIRED FOR SETTING DESIRED TORQUE	
	ACCURACY	+3% OF SET VALUE	
LIMIT SWITCH (Not Applicable for Smart Actuator) **($$ Refer Notes)**	MFR & MODEL NO.	BIDDER TO SPECIFY	
	OPEN : INT : CLOSE	■2 Nos. / 2 nos(adj) / 1 No. ■2Nos.	
	CONTACT TYPE	2 NO + 2 NC	
	RATING (AC / DC)	5A 250V AC AND 0.5A 220V DC	

BHEL	**SPECIFICATION FOR MOTORISED VALVE ACTUATOR**	SPECIFICATION NO.:	
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Data Sheet A & B

DATA SHEET-A (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)

POSITION TRANSMITTER	POSITION TRANSMITTER (For inching duty & other specific applications)	REQUIRED for regulating/inching duty only.	
	MFR & MODEL NO.	BIDDER TO SPECIFY	
	TYPE	☐ ELECTRONIC (2 WIRE) R/I CONVERTER ■ ELECTRONIC (2 WIRE) contactless inductive type	
	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)	BIDDER TO SPECIFY	
	@ RATING		
TERMINAL BOX	ACTUATOR/MOTOR TERMINAL BOX	REQUIRED	
	ENCL CLASS ACTUATOR/MOTOR T.B.	@■ IP 68 @☐ NEMA6	
	@ EARTHING TERMINAL	REQUIRED	
	PLUG & SOCKET(9 PIN) (FOR COMMD, LS/TS FEED BACK, PoT)	■ REQUIRED ☐ NOT REQUIRED☐ ■ 2 NOS. ☐ ----------	
CABLE GLANDS	@ POWER CABLE GLAND	SIZE:----------	
	@ SPACE HEATER CABLE GLAND	SIZE:----------	
	OTHER CONTROL CABLE GLANDS-1	☐ 1No. for BFV of CW PUMP(Cable size 2Px1.5mm2)	
	OTHER CONTROL CABLE GLANDS-2	1 no suitable for 8P X 0.5 sq mm Additional 1 no suitable for 2P X 0.5 sq mm(inching duty only)	

BHEL	**SPECIFICATION FOR MOTORISED VALVE ACTUATOR**	SPECIFICATION NO.:
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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 SHOULD BE POSSIBLE 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 1.5 SQ. MM.

11. THE MOTOR SHALL BE CAPABLE OF STARTING AT 85 PERCENT OF RATED VOLTAGE AND RUNNING AT 80 PERCENT OF RATED VOLTAGE AT RATED TORQUE AND 85 PERCENT RATED VOLTAGE AT 33 PERCENT EXCESS RATED TORQUE FOR A PERIOD OF 5 MINUTES EACH.

12. THE ACTUATORS SHALL BE DESIGNED TO BE SELF-LOCKING UPON LOSS OF POWER. MOTOR SHALL BE DESIGNED TO CLOSE IN 30 SECS. FROM FULL OPEN POSITION AND SHALL HAVE ADEQUATE CAPACITY TO OPEN AND CLOSE UNDER FULL UNBALANCED DESIGN PRESSURE.

13. ALL SIX (6) LIMIT SWITCHES SHALL BE CHANGEOVER TYPE AND ADJUSTABLE BESIDES HAVING THE SNAP FACILITY.

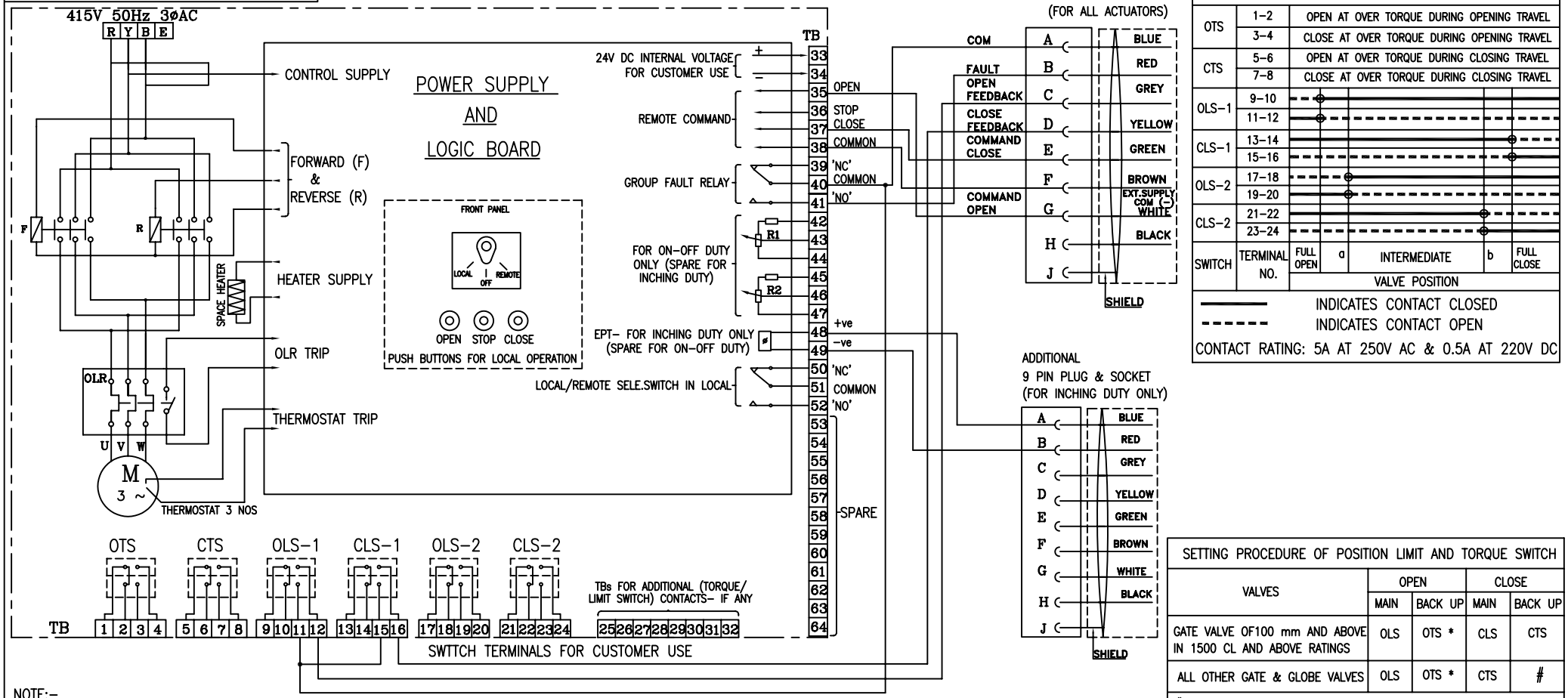
14. THE INTEGRAL STARTER WHICH SHALL HAVE SOPHISTICATED ELECTRONIC CONTROLS WITH FIELD PROGRAMMING FEATURE. IT SHALL BE DESIGNED FOR REMOTE CONTROL FROM DCS/RESPECTIVE CONTROL SYSTEM. REQUIRED INTERPOSING RELAYS FOR RECEIVING OPEN/CLOSE/STOP COMMAND FROM DCS/RESPECTIVE CONTROL SYSTEM SHALL BE PROVIDED. POTENTIAL FREE CONTACTS AND TRANSDUCERS SHALL BE PROVIDED TO PROVIDE STATUS INDICATION AT REMOTE DCS/RESPECTIVE CONTROL SYSTEM.

15. THE REMOTE COMMAND SIGNAL (OPEN-STOP-CLOSE) FROM DCS/RESPECTIVE CONTROL SYSTEM/CONTROL PANEL SHALL BE ISOLATED FROM CONTROL ELECTRONICS THROUGH OPTO-ISOLATOR.

16. THE FOLLOWING INDIVIDUAL STATUS ANNUNCIATION LED'S (COLOUR-GREEN) SHALL BE PROVIDED LOCALLY (INTEGRAL TO ACTUATOR) TO ANNUNCIATE THE FOLLOWING FOR EASY LOCAL MONITORING.
    ACTUATOR IN LOCAL MODE
    ACTUATOR IN REMOTE MODE
    ACTUATOR RUNNING IN OPEN DIRECTION
    ACTUATOR RUNNING IN CLOSE DIRECTION
    ACTUATOR IN INCHING MODE.
    ACTUATOR IN SELF-RETAINING MODE
    LIMIT SWITCH OPEN TRIP
    LIMIT SWITCH CLOSE TRIP
    CONTROL VOLTAGE AVAILABILITY

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.

This pg is part of spec PE-TS-426-673A-A001

REV	DATE	ALTERED
		CHD & APPD

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247/500

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

CHAPTER –11: CONTROL VALVES WITH ACTUATORS

11.01.00 CONTROL VALVES, ACTUATORS & ACCESSORIES

11.01.00 **General Requirements**

11.01.01 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.

11.01.02 All the control valves and accessories offered by the Bidder shall be from reputed, experienced manufacturers of specified type and range of valves.

11.01.03 For special type of control valves such as combined pressure and temperature control valves for Aux PRDS application, separator drain control valves, also refer to the corresponding mechanical sections.

Control valve station shall be provided at the interconnection line between service air header and instrument air header before air dryer unit. When instrument air header pressure falls below set value, the control valve will start opening and maintain the instrument header pressure at specified level in line with plant requirement. Again when instrument air header pressure goes above specified level in line with plant requirement the control valve will fully close automatically. Complete system shall be in bidder scope.

11.02.00 **CONTROL VALVE SIZING & CONSTRUCTION**

11.02.01 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.

11.02.02 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 trim exit 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 Owner's approval during detailed engineering.

11.02.03 Control valves for steam and water applications shall be designed to prevent cavitation, wire drawing, flashing on the downstream side of valve and downstream piping. Thus for cavitation/flashing service, only valve with anti cavitations trim shall be provided. Detailed calculations to establish whether cavitation will occur or not for any given application shall be furnished.

11.02.04 Control valves for application such as Feed water control valve, HP & LP by pass spray control valves, APRDS control valves, Soot blower control valve, separator drain control valve, 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 minimum 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.

11.02.05 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.

11.02.06 The Liquid pressure recovery factor (FL) shall be 0.995 or better for severe flashing/cavitation services.

11.02.07 The Liquid pressure recovery factor (FL) shall be 0.985 or better for low flashing/cavitation services.

11.02.08 The valve travel time shall be less than 10 second for non critical services valves.

11.02.09 Rangeability should be 50 to 1 (min.) for non critical services valves.

11.02.10 Modulating Type Control Valve's Linearity, Hysteresis, Accuracy shall be < +1% and Sensitivity shall be < + 0.5%.

11.03.00 VALVE CONSTRUCTION

11.03.01 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.

11.03.02 Valves with high lift cage guided plugs & quick-change trims shall be supplied.

11.03.03 Cast Iron valves are not acceptable.

11.03.04 Bonnet joints for all control valves shall be of the flanged and bolted type or other construction acceptable to the Owner. Bonnet joints of the internal threaded or union type will not be acceptable.

11.03.05 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.

11.03.06 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)

11.03.07 Valve characteristic shall match with the process characteristics.

11.03.08 Extension bonnets shall be provided when the maximum temperature of flowing fluid is greater than 280 deg. C.

11.03.09 Flanged valves shall be rated at no less then ANSI press class of 300 lbs.

11.04.00 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 fluid temperature below 275 Deg. C Alloy steel ASTM-A217Gr. WC9 for fluid temperature above 275 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 services	Alloy steel ASTM-A217 Gr. WC6	17-4 PH SS
4	DM water services	SS 316	316 SS

NOTE Valve body rating shall meet the process pressure and temperature requirement as per ANSI B16.34.

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 Owner's consideration and approval.

11.05.00 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 Owner'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.

11.06.00 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 HP & LP bypass valves, 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.

11.07.00 CONTROL VALVE ACCESSORY DEVICES

11.07.01 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.

11.08.00 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 with Die cast Aluminum/SS316 enclosure.
3	Software for Configuration and Diagnostics	Software	Windows based 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 (Pressure versus Valve travel and Travel versus 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.
11	EMC & CE compliance	Required to International Standard like EN/IEC.	EN50081-2 & EN 50082 or equivalent.

12	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 Vol-V C&I :).
		Pressure Gauge Block & Position Indicators.	For supply & output pressures, Air Filter Regulator, integral type position transmitter, in built mechanical position indicator 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 Vol-V, Part B, Chapter 3, DDCMIS, cl. no. 3.45.00

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 "Remote Configuration and Diagnostics", and this software shall be loaded in the HART management system.

11.09.00 <u>FOR FOLLOWING CRITICAL APPLICATION SPECIAL CONTROL VALVES ARE REQUIRED:</u>

1. HP & LP Bypass Valves and Control System
2. BFP – Minimum Re-circulation Valve
3. Feed Water Control Valve
4. SH & RH spray Control Valves
5. APRDS System
6. Soot Blower control valve
7. Separator Drain Control Valve.
8. Fuel oil heating and pressurizing
9. Minimum economizer flow control
10. DM make up (emergency / normal)

11. Control valves whose down stream are connected to vacuum such as HP/LP heater emergency level control.

12. CEP minimum flow control

11.09.01 <u>General Requirements for Critical Application Control Valves</u> -.

i) The valve accessories shall include hand wheels, limit switches, smart valve positioner (4-20mA DC type), electro pneumatic converter, Air lock relay, Solenoid valve and all other items required for the completeness and the accessories shall be explosion proof type as per hazardous area classification wherever applicable.

ii) Control valves shall be furnished with IBR certification wherever required.

1. **Noise:** The maximum allowable noise level shall be 85 dba or less at 1 m. distance from the downstream bare pipe surface. The specified noise level shall be attained without the use of orifices, mufflers, diffusers. No credit for thermal or acoustical insulations shall be taken.

2. **Valve Trim:** Valve shall have quick change type trim utilizing top entry. No components shall be screwed or welded into the body. The valve shall have equal pressure distribution around the plug to avoid chattering / vibration.

   Trim of severe/critical service valve shall be of multi stage & multi path design with sufficient no. of discrete pressure drop stage to eliminate the chance of erosion, cavitations, noise, vibration through out the control range of valve.

3. **Leakage Class:** The valve shall have minimum class-V leakage for all steam applications including RH/SH, APRDS, Soot Blower control valve, HP/LP Bypass spray control valves, BFP minimum recirculation valve & Low Load feed water control valve.

   In case of HP/LP Bypass control valve application, the leakage class should be MSS-SP 61 (block valve leakage).

4. **Actuator:** Actuator type should be pneumatic double acting piston/electro-Hydraulic.

11.10.00 TEST AND EXAMINATION

All valves shall be tested in accordance with the quality assurance program agreed between the Owner 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:

11.10.01 Non Destructive Test as per ANSI B-16.34.

11.10.02 Hydrostatic shell test in accordance with ANSI B 16.34 prior to seat leakage test.

11.10.03 Valve closure test and seat leakage test in accordance with ANSI-B 16.34 and as per the leakage class indicated above.

11.10.04 Functional Test: The fully assembled valves including actuators control devices

and accessories shall be functionally tested to demonstrate times from open to close position.

11.10.05 CV Test: Please refer Cl No. 13.00.00, Vol. V Part-B, Chapter : 13 (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 chapter has to be read in conjunction with other relevant chapter of this specification.

INSTRUMENTS CHECK LIST

off, then the cost shall not be payable.

13.01.00 SPECIAL REQUIREMENT FOR SOLID STATE EQUIPMENTS/ SYSTEMS

13.01.01 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.

13.02.00 TYPE TEST REQUIREMENT FOR C&I SYSTEMS

S.NO Col1	Item Col2	Test Requirement Col3	Standard Col4	Test to be specifically conducted Col5	UPRVUNL's Approval required on Test certificate Col6
1	Elect. Metering instruments	As per Standard (col4)	IS-1248	No	Yes
2	Transducers	As per	IEC-	No	Yes

		Standard (col4)	60688,IS12784		
3	Thermocouple	Degree Protection Test	IS-13947	No	No
4	RTD	As per Standard (col4)	IEC-60751	No	No
5	Electronic Transmitters	As per Standard (col4)	BS-6447/ IEC-60770	No	Yes
6	E/P converter	As per Standard (col4)	Mfr. standard	No	Yes
7	Dust emission monitor	Degree Protection Test	IS-13947	No	Yes
8	Instrumentation Cables Twisted & Shielded*				
	Conductor	Resistance	VDE-0815, IS: 10810	No	Yes
		Diameter test	IS-10810	No	Yes
		Tin Coating test (per sulphate	IS-8130/84	No	Yes
	Insulation	Loss of mass	VDE 0472, IS:5831/1984	No	Yes
		Ageing in air ovens**	VDE 0472, IS:5831/1984	No	Yes
		Tensile strength and elongation test before and after ageing**	VDE 0472, IS:5831/1984	No	Yes
		Heat shock	VDE 0472, IS:5831/1984	No	Yes
		Hot deformation	VDE 0472	No	Yes
		Shrinkage	VDE 0472, IS:5831/1984	No	Yes
		Bleeding and Blooming	IS-10810, IS:5831/1984	No	Yes
		Cold bend test for PVC insulation.	IS:5831/1984		
		Insulation Resistance Test (Volume Resistivity method)	As per GTP		
	Inner sheath***	Loss of mass	VDE 0472, IS:5831/1984	No	Yes
		Heat shock	VDE 0472, IS:5831/1984	No	Yes
		Cold bend/ cold impact test	VDE 0472, IS:5831/1984	No	Yes
		Hot deformation	VDE 0472	No	Yes
		Shrinkage	VDE 0472,	No	Yes

			IS:5831/1984		
	Outer sheath	Loss of mass	VDE 0472, IS:5831/1984	No	Yes
		Ageing in air ovens**	VDE 0472, IS:5831/1984	No	Yes
		Tensile strength and elongation test before and after ageing**	VDE 0472, IS:5831/1984	No	Yes
		Heat shock	VDE 0472, IS:5831/1984	No	Yes
		Hot deformation	VDE 0472	No	Yes
		Shrinkage	VDE 0472, IS:5831/1984	No	Yes
		Bleeding and Blooming	IS-10810, IS:5831/1984	No	Yes
		Colour fastness to water	IS-5831/1984	No	Yes
		Cold/bend cold impact test	VDE 0472, IS:5831/1984	No	Yes
		Oxygen index test	ASTMD-2863/77	No	Yes
		Smoke density test	ASTMD-2863, ASTM-D-2843/77	No	Yes
		Acid gas generation test	IEC-60754-1	No	Yes
	fillers				
		Oxygen index test	ASTMD-2863, IEC 60754-1	No	Yes
		Acid gas generation test	IEC-60754-1	No	Yes
	AL-MYLAR shield				
		Continuity Test	As per GTP	No	Yes
		Shield Thickness		No	Yes
		Overlap test		No	Yes
	Over all cable				
		Flammability Test	IEEE 383, IEEE-332 Part -3 (Category-B)	No	Yes
		Swedish chimney test	SEN 4241475	No	Yes
		Noise interference	IEEE Transactions	No	Yes
		Dimensional checks	IS 10810	No	Yes
		Cross talk	VDE-0472	No	Yes

		Mutual capacitance	VDE-0472	No	Yes
		HV test	VDE-0815, As per GTP	No	Yes
		Drain wire continuity	VDE 0472	No	Yes
	* 1.0 All cables to be supplied shall be of type tested quality. The Bidder shall submit for Owner's approval the reports of all the type tests as listed in this specification and carried out within last five 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 Bidder is not able to submit report of the type test(s) conducted within last five 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 Bidder 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, EN61000-4-12	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	IEC-68-2-6 or equivalent	No	Yes
		Electrostatic discharge test	EN 61000-4-2 or equivalent	No	Yes
		Radio frequency immunity test	EN 61000-4-3 or equivalent	No	Yes
		Electromagnetic field immunity	EN 61000-4-3 or equivalent	No	Yes
		Degree of Protection	IS-13947 or equivalent	No	Yes
10	Battery##	As per stand	IS-10918	No	Yes

		col 4			
11	UPS (Applicable for each model and rating)				
	1) Type Test reports of same series of UPS with similar PCB's cards and controllers as the target UPS system shall be acceptable.				
	2) For Dry heat, Damp heat and vibration, the tests conducted on individual PCB's shall be acceptable.				
		Surge Withstand capability (SWC)	ANSI 37.90.1 IEEE-472, EN61000-4-12	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	IEC-68-2-6 or equivalent	No	Yes
		Electrostatic discharge test	EN 61000-4-2 or equivalent	No	Yes
		Radio frequency immunity test	EN 61000-4-3 or equivalent	No	Yes
		Electromagnetic field immunity	EN 61000-4-3 or equivalent	No	Yes
		Degree of Protection	IS-13947 or equivalent	No	Yes
		Fuse clearing capability	Approved procedure	No	Yes
		Short circuit current capability	IEC 60146-2	No	Yes
	Voltage stabilizers	Over Load Test	Approved procedure	No	Yes
		Temp rise test without redundant fans	Approved procedure	No	Yes
	LIE / LIR	Degree of protection Test	IS-13947	No	Yes
	Flue Gas Analysers	Degree of protection Test	IS-13947	No	Yes
	Master clock	Functional test	As per Approved procedure	No	Yes
	CJC Box	Degree of protection Test	IS-13947	No	Yes
	Junction Box	Degree of protection Test	IS-13947	No	Yes
	OPC data	OPC		No	Yes

	access server Data exchange server and Historical data access server	Compliance testing			(Self certification is also acceptable)
	Conductivity type level switch	Degree of protection Test	IS-2147	No	No
	Local Gauges	Degree of protection Test	IS-2147	No	No
	Process actuated switches	Degree of protection Test	IS-2147	No	No
	Control Valves	CV Test	ISA 75.02	No	Yes
	PLCs	As per standard (col4) and cl. No. 13.03.00 below.	IEC 1131	No	No
	Flow Nozzle orifice plate	Calibration	ASME PTC BS 1042	No	Yes
	## The bidder shall submit for Owners approval the reports of all the type test as per latest IS-10918 carried out within last five 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.				

13.03.00 **TYPE TESTS for PLC**

13.03.01 All equipments to be supplied shall be of type tested quality. The bidder shall submit for Owner's approval the reports of all the type testes as listed in this specification and carried out within last five 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.
However if the bidder is not able to submit report of the type tests(s) conducted within last five years from the date of bid opening, or in case the type tests(s) are not found meeting the specification requirements, the Bidder shall conduct all such tests under this contract, at no additional cost to the owner either at third part lab or in presence of clients/owners representative and submit the reports for approval.

13.03.02 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.

CHECK LIST FOR PRESSURE SWITCH

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	
	1.1 MODEL NO/TAG NO						
	1.2 RANGE						
	1.3 END CONN						
	1.4 NO. OF CONTACT						
2	CALIBRATION			P	V	V	
	2.1 REPEATABILITY						
	2.2 SET POINT ADJUSTMENT						
	2.3 DIFFERENTIAL						
3	OVER PR & LEAK TEST			P	V	V	
4	ELECT. INSULATION/HV TEST	ONE		P	V	V	
5	REVIEW OF TC FOR MATERIALS OF	FOR LOT		V	V	V	
	5.1 SENSOR						
	5.2 MOVEMENT						
	5.3 PROCESS CONNECTION						
	5.4 HOUSING						
6	REVIEW OF TC FOR DEGREE OF PROTECTION	TYPE TEST		V	V	V	
7	REVIEW OF TC OF MICROSWITCH	FOR LOT		V	V	V	

** 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 carry out ROUTINE TEST on 100 %.
3. Contractor to provide compliance certificate for tests/checks verifid by contractor and the same alongwith test certificates to be verified by BHEL

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR TRANSMITTER

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECKS FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	VISUAL.						
	MODEL/TAG No						
2	PROCESS CONNECTION			P	W	V	
3	ACCURACY			P	W	V	
4	REPEATABILITY			P	W	V	
5	HYSTERESIS			P	W	V	
6	EFFECT OF TEMP VARIATION ON ACCURACY			P	W	V	
7	SPAN / ZERO ADJUSTMENT	ONE / TYPE		P	W	V	
8	EFFECT OF SUPPLY VOLTAGE VARIATION			P	W	V	
9	EFFECT OF LOADING (500 OHM METERS)			P	W	V	
10	HIGH PRESSURE TEST	SEE NOTE-1 BELOW		P	W	V	
11	BURN-IN TEST	ONE / TYPE		P	W	V	
12	DEGREE OF PROTECTION			P	W	V	
13	ACCESSORIES AS APPLICABLE	SEE NOTE-1 BELOW		V	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. When material corelation are not available manufacturer's compliance to be provided.
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 PRESSURE & DP 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	P	W	V	
	SENSOR TYPE						
	DIAL SIZE						
	MODEL NO/TAG NO						
	RANGE/SCALE						
	SWITCH CONTACT RATING & NOS.						
	END CONNECTION						
2	CALIBRATION			P	W	V	
	ACCURACY						
	REPEATABILITY						
	SET POINT ADJUSTMENT						
3	OVER PRESSURE & LEAK TEST			P	W	V	
4	OPERATION OF PRESSURE. RELIEF DEVICE	ONE		P	W	V	
5	REVIEW OF TC FOR	FOR LOT		V	V	V	
	MATERIALS OF SENSOR						
	MOVEMENT						
	PROCESS CONNECTION						
	HOUSING						
6	REVIEW OF TC FOR DEGREE OF PROTECTION	TYPE TEST		V	V	V	
7	ACCESSORIES AS APPLICABLE	SEE NOTE-1 BELOW		V	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. Manufacturer to carry out ROUTINE TEST on 100 %.
4. When material corelation is not available, MFR's compliance to be provided
5. 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.

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR ANNUNCIATORS

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/ MODEL						
	DIMENSIONS OF HARDWARE						
	MODULARITY						
	SEQUENCE						
	FACIA DETAILS						
2	FUNCTIONAL TEST	100%		P	W	V	
3	IMMUNE TO STEP VARIATIONS IN THE POWER SUPPLY	SEE NOTE-1 BELOW		P	W	V	
4	DEGREE OF PROTECTION FOR ENCLOSURE	TYPE TEST		P	W	V	
5	I/R CHECK	SEE NOTE-1 BELOW		P	W	V	
6	RESPONSE			P	W	V	

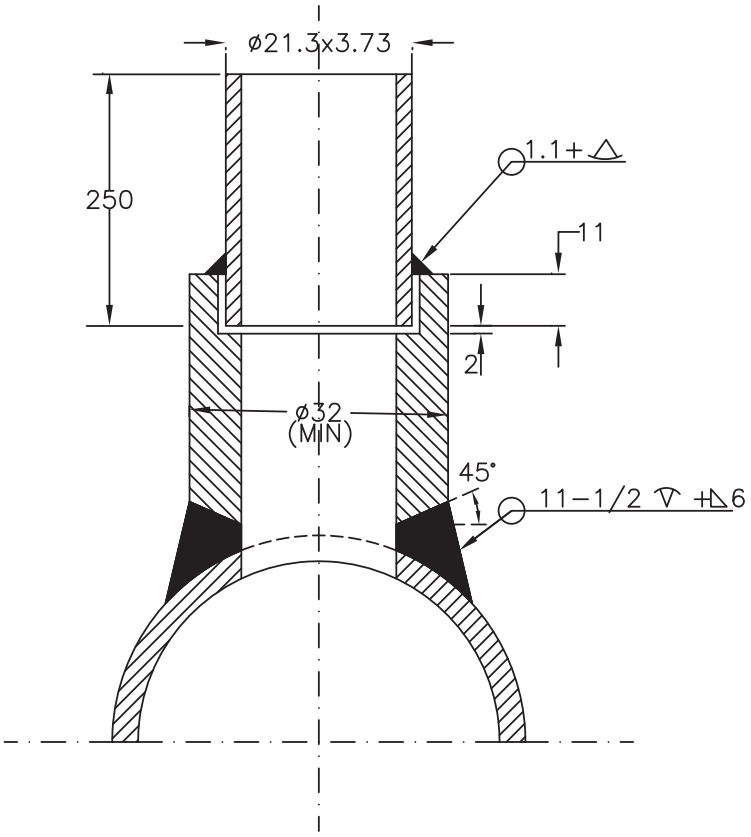
Legend :

** 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.

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. THE OTHER END OF THE NIPPLE SHALL BE SOCKET WELDED WITH 1/2" GLOBE VALVE OF MATERIAL AS PER ANSI B 31.1.
4. TWO ISOLATION VALVES ARE TO BE USED FOR PRESSURE EXCEEDING 40 Kg/Cm2.
5. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED.
6. EDGE HOLE MUST BE CLEAN AND SQUARE OR ROUNDED SLIGHTLY(1/64" RADIUS) FREE FROM BURRS, WIRE EDGES OR OTHER IRREGULARITIES.
7. FOR PU COATED PIPE REFER SHT NO.7

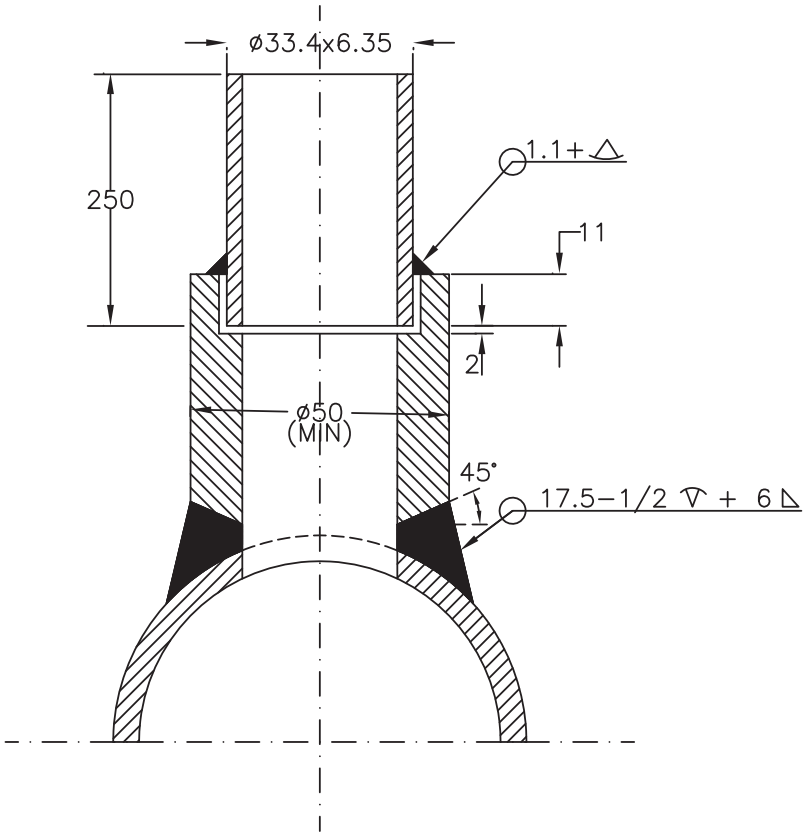
TITLE :

STD INSTRUMENT STUB DETAILS

PRESSURE STUB

SYSTEM PRESS < 60Kg/Cm2 & SYSTEM TEMP<425 Deg C, Nb15 , CL3000

DRG. NO. PE-DG-426-145-I101
REV. 00
SH. 02 OF 08



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. THE OTHER END OF THE NIPPLE SHALL BE SOCKET WELDED WITH 1" GLOBE VALVE OF MATERIAL AS PER ANSI B 31.1.
4. TWO ISOLATED VALVES ARE TO BE USED.
5. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED.
6. EDGE HOLE MUST BE CLEAN AND SQUARE OR ROUNDED SLIGHTLY(1/64" RADIUS) FREE FROM BURRS, WIRE EDGES OR OTHER IRREGULARITIES.

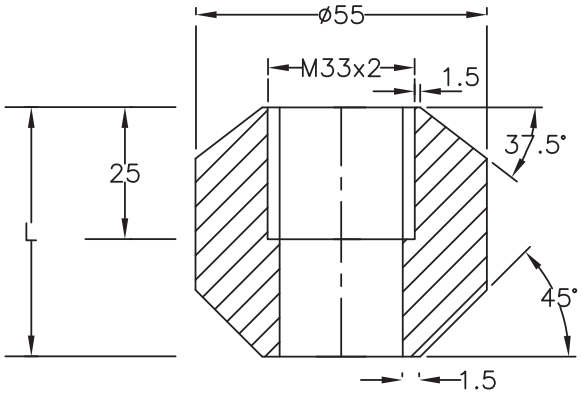
TITLE :

STD INSTRUMENT STUB DETAILS

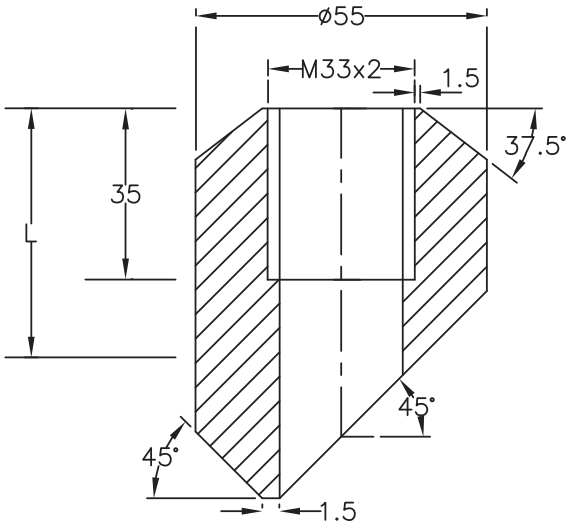
PRESSURE STUB

DRG. NO.
PE-DG-426-145-I101
REV. 00
SH. 03 OF 08

SYSTEM PRESS > 60Kg/Cm2 & 425 Deg C < SYSTEM TEMP <= 500 Deg C , Nb25 , CL3000/6000



TEMPERATURE STUB FOR STRAIGHT IMMERSION



TEMPERATURE STUB FOR SLANT IMMERSION

NOTE :

1. MATERIAL OF THE BOSS SHALL BE THE SAME AS THE PIPE INTO WHICH IT IS WELDED.
2. LENGTH OF THE STUB (L) SHALL BE 64/45 mm DEPENDING UPON PIPE SIZE, AS PER CORPORATE STD. AA 7326102.(FOR PIPE OD 88.9 mm TO 159 mm STUB HEIGHT SHALL BE=64mm & FOR PIPE OD ⩾219.1mm STUB HEIGHT SHALL BE=45mm)
3. STRAIGHT IMMERSION STUBS SHALL BE USED FOR PIPE OD'S 168.3 mm & ABOVE. THE STUB HEIGHT FOR PIPE OD 168.3 mm TO <219.1 mm SHALL BE 64 mm.
4. SLANT IMMERSION STUBS SHALL BE USED FOR PIPE OD'S 88.9 mm TO 159 mm.
5. FOR MAIN PIPE OD'S 88.9 mm & BELOW SUITABLE EXPANDER SHALL BE USED.
6. PLEASE REFER SHEET–6 FOR THERMOWELL INSTALLATION.
7. FOR PU COATED PIPE REFER SHT NO.8

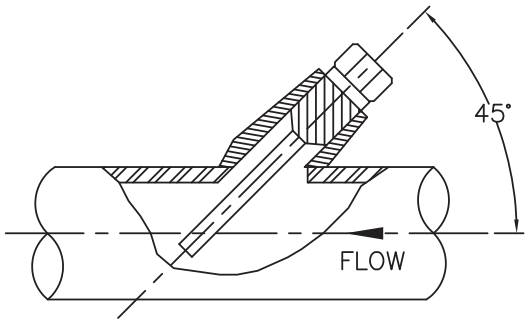
TITLE :

भेल BHEL

STD INSTRUMENT STUB DETAILS

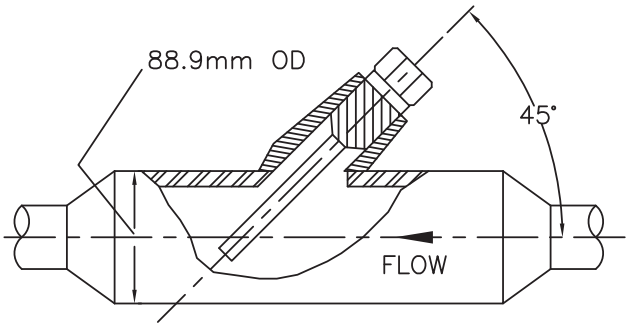
TEMPERATURE STUB

DRG. NO.
PE-DG-426-145-I101
REV. 00
SH. 05 OF 08



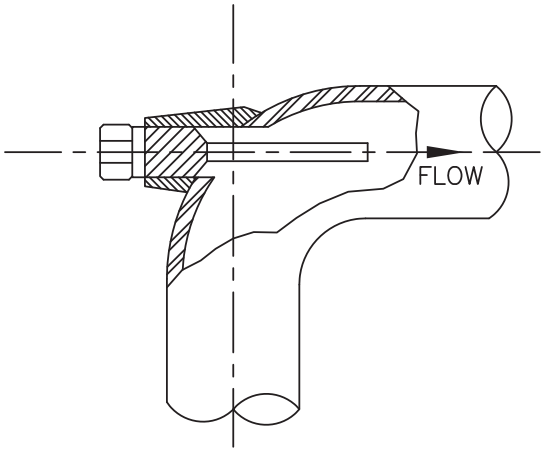
INSTALLATION TYPE–1

FOR MAIN PIPE OD 88.9mm to 159mm



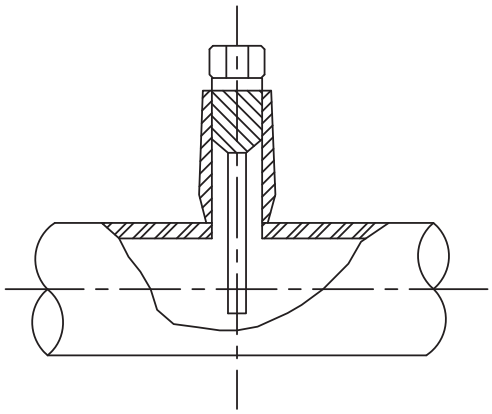
INSTALLATION TYPE–2

FOR MAIN PIPE OD BELOW 88.9mm



INSTALLATION TYPE–3

FOR MAIN PIPE OD 88.9mm & BELOW



INSTALLATION TYPE–4

FOR MAIN PIPE OD 168.3mm & ABOVE

TITLE :

STD INSTRUMENT STUB DETAILS

THERMOWELL INSTALLATION

DRG. NO.
PE-DG-426-145-I101
REV 00
SH. 06 OF 08

INSTRUMENT INSTALLATION DIAGRAM

LIST OF INSTRUMENT INSTALLATION DIAGRAM

S.NO.	DESCRIPTION	DWG.NO.	REV.	SHT.NO.
1	LIST OF INSTRUMENT INSTALLATION DIAGRAM	14A14-DWG-I-0010	0	1 OF 19
2	INSTRUMENT INSTALLATION DIAGRAM FOR 'U' TUBE	14A14-DWG-I-0010	0	2 OF 19
3	INSTRUMENT INSTALLATION DIAGRAM FOR FLOW MEASUREMENT.	14A14-DWG-I-0010	0	3A OF 19 3B OF 19
4	INSTRUMENT INSTALLATION DIAGRAM FOR PRESSURE & DIFF. PRESSURE TRANSMITTER/SWITCH (OIL SERVICE)	14A14-DWG-I-0010	0	4 OF 19
5	INSTRUMENT INSTALLATION DIAGRAM FOR PRESSURE & DIFF. PRESSURE TRANSMITTERS/SWITCH (AIR SERVICE)	14A14-DWG-I-0010	0	5 OF 19
6	INSTRUMENT INSTALLATION DIAGRAM FOR PRESSURE & DIFF. PRESSURE TRANSMITTERS/SWITCH (STEAM & LIQUID SERVICE)	14A14-DWG-I-0010	0	6 OF 19
7	INSTRUMENT INSTALLATION DIAGRAM FOR PRESSURE & DIFF. PRESSURE TRANSMITTERS/SWITCH (STEAM & LIQUID SERVICE)	14A14-DWG-I-0010	0	7 OF 19
8	INSTRUMENT INSTALLATION DIAGRAM FOR PRESSURE & DIFF. PRESSURE TRANSMITTERS/SWITCH (FLUE GAS SERVICE)	14A14-DWG-I-0010	0	8 OF 19
9	INSTRUMENT INSTALLATION DIAGRAM FOR LOCAL PRESSURE GAUGE	14A14-DWG-I-0010	0	9 OF 19
10	INSTRUMENT INSTALLATION DIAGRAM FOR FLOW TRANSMITTERS (AIR SERVICE)	14A14-DWG-I-0010	0	10 OF 19
11	IINSTRUMENT INSTALLATION DIAGRAM FOR DIFF. PRESSURE SWITCH/GAUGE/LEVEL SWITCHS	14A14-DWG-I-0010	0	11 OF 19
12	INSTRUMENT INSTALLATION DIAGRAM FOR FLOW TRANSMITTERS (WATER & STEAM SERVICE)	14A14-DWG-I-0010	0	12A OF 19 12B OF 19
13	INSTRUMENT INSTALLATION DIAGRAM FOR LEVEL TRANSMITTERS	14A14-DWG-I-0010	0	13 OF 19
14	INSTRUMENT INSTALLATION DIAGRAM FOR TEMPERATURE STUB	14A14-DWG-I-0010	0	14 OF 19
15	INSTRUMENT INSTALLATION DIAGRAM FOR TEMPERATURE STUB	14A14-DWG-I-0010	0	15 OF 19
16	INSTRUMENT INSTALLATION DIAGRAM FOR AIR PURGING	14A14-DWG-I-0010	0	16 OF 19
17	INSTRUMENT INSTALLATION DIAGRAM FOR LEVEL SWITCH OPTION-1 WITH FLANGED CONNECTION	14A14-DWG-I-0010	0	17 OF 19
18	INSTRUMENT INSTALLATION DIAGRAM FOR LEVEL SWITCH OPTION-2 WITH FLANGED CONNECTION	14A14-DWG-I-0010	0	18 OF 19
19	INSTRUMENT INSTALLATION DIAGRAM FOR CONTROL VALVE (WITH PNEUMATIC ACTUATOR)	14A14-DWG-I-0010	0	19 OF 19

PRELIMINARY

REVIEWED											
			AC	PB	PB	AAM	PRELIMINARY		0	27.01.15
			APPROVED	REVIEWED	CHECKED	DRAWN	DESCRIPTION	RELEASE STATUS	REV.	DATE

INSTRUMENT INSTALLATION DIAGRAM

PANKI THERMAL POWER STATION
1 x 660 MW UNIT
KANPUR (UP)

UTTAR PRADESH RAJYA VIDYUT UTPADAN NIGAM LIMITED

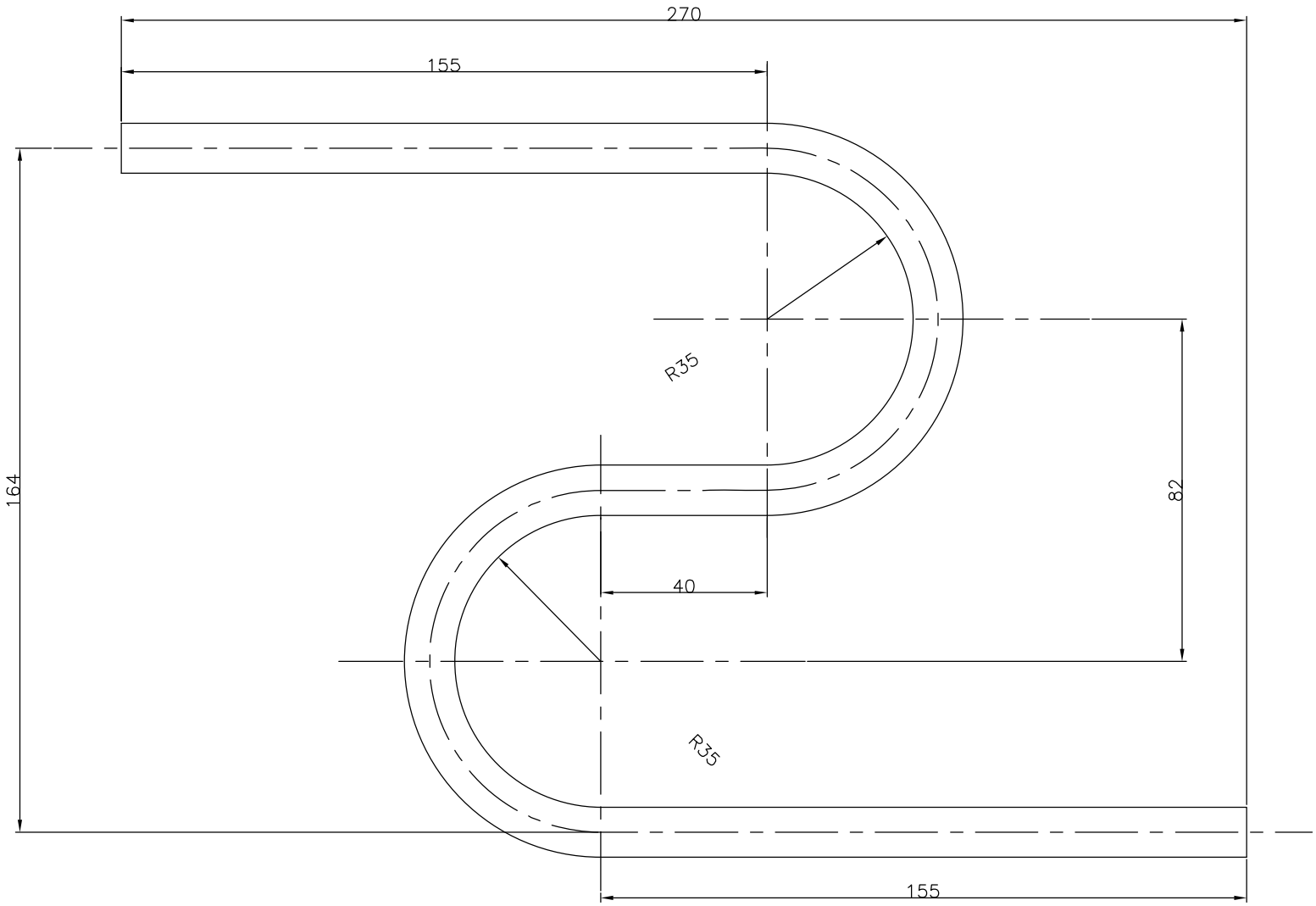
DEVELOPMENT CONSULTANTS PVT. LTD
CONSULTING ENGINEERS

JOB NO. 14A14 | SCALE : NIL

DWG. NO. 14A14-DWG-I-0010 | SHT. 1 OF 19 | REV. 0

FILE NAME 14A14-DWG-I-0010-R0

A3 (9-96) [420x297]



FOR 'U'–TUBE

PRELIMINARY

REVIEWED											
			AC	PB	PB	AAM	PRELIMINARY		0	27.01.15
			APPROVED	REVIEWED	CHECKED	DRAWN	DESCRIPTION	RELEASE STATUS	REV.	DATE

INSTRUMENT INSTALLATION DIAGRAM

PANKI THERMAL POWER STATION
1 x 660 MW UNIT
KANPUR (UP)

UTTAR PRADESH RAJYA VIDYUT UTPADAN NIGAM LIMITED

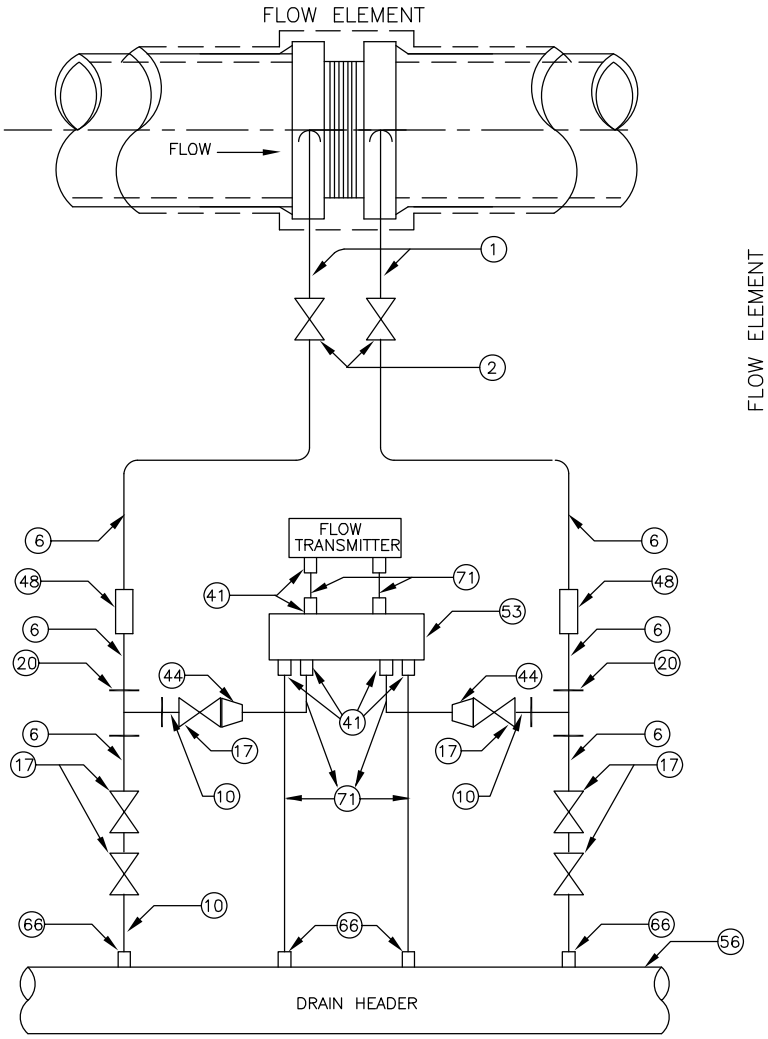
DEVELOPMENT CONSULTANTS PVT. LTD
CONSULTING ENGINEERS

JOB NO. 14A14 | SCALE : NIL

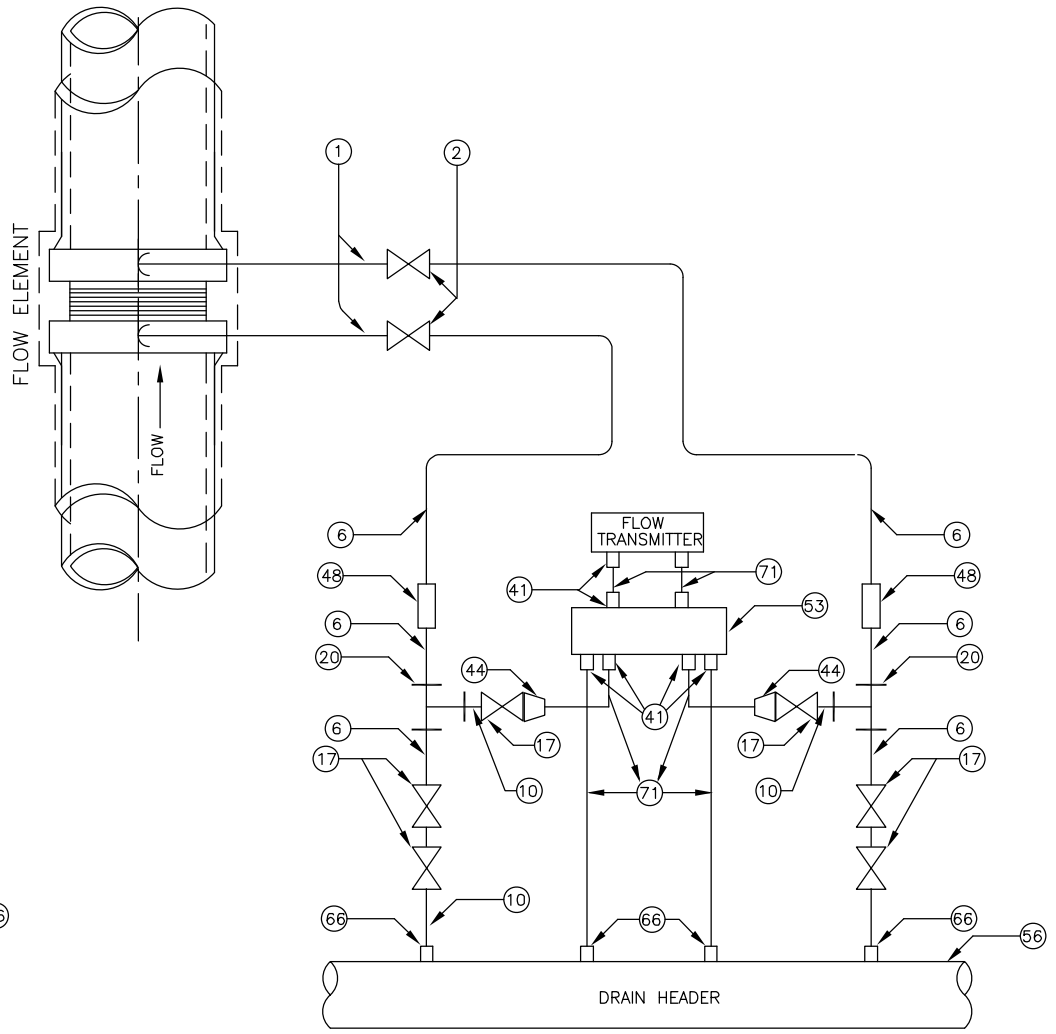
DWG. NO. 14A14–DWG–I–0010 | SHT. 2 OF 19 | REV. 0

FILE NAME 14A14–DWG–I–0010–R0

A3 (9–96) [420x297]



HORIZONTAL PIPE RUN
FIG–A



VERTICAL PIPE RUN
FIG–B

NOTE:–

FOR PROCESS PR. ABOVE 40Kg/sqcm DOUBLE VLV.
SHALL BE USED FOR CONNECTION TO THE DRAIN HEADER

FOR FLOW MEASUREMENT

PRELIMINARY

REVIEWED										
			AC	PB	PB	AAM	PRELIMINARY		0	27.01.15
			APPROVED	REVIEWED	CHECKED	DRAWN	DESCRIPTION	RELEASE STATUS	REV.	DATE

INSTRUMENT INSTALLATION DIAGRAM

PANKI THERMAL POWER STATION
1 x 660 MW UNIT
KANPUR (UP)

UTTAR PRADESH RAJYA VIDYUT UTPADAN NIGAM LIMITED

DEVELOPMENT CONSULTANTS PVT. LTD
CONSULTING ENGINEERS

JOB NO. 14A14 | SCALE : NIL

DWG. NO. 14A14–DWG–I–0010 | SHT. 3A OF 19 | REV. 0

FILE NAME 14A14–DWG–I–0010–R0

A3 (9–96) [420x297]

BILL OF MATERIAL FOR FLOW MEASUREMENT

TAG NO.	DESCRIPTION	QTY.	
		A	B
1	1/2" NPS SCH 80 NIPPLES OF MATERIAL SAME AS MAIN PIPE WITH NECESSARY ATTACH TO FLANGES	AS REQD.	
2	1/2" SOCKET WELDED GLOBE VALVE	2	2
6	1/2" NPS SCH 80/160 CS/AS PIPE	AS REQD.	
10	1/2" NPS SCH 80/160,CS/AS NIPPLE	4	4
17	1/2" SOCKET WELDED CS GLOBE VALVE	4	4
20	1/2" SOCKET WELDED EQUAL TEE CS/AS	2	2
41	1/2"NPT(M)X1/2"OD TUBE COMPRESSION FITTING,SS-316	8	8
44	1/2"BWX1/2"OD COMPRESSION TUBE FITTING,SS-316	2	2
48	1/2" SW, CS/AS BULK HEAD PIPE UNION	2	2
53	5-VALVE MANIFOLD, SS-316	1	1
56	2"NB GI DRAIN HEADER	AS REQD.	
66	1/2" GI SOCKET / FUNNEL	4	4
71	1/2"OD IMPULSE TUBE, SS 316	AS REQD.	

PRELIMINARY

REVIEWED											
			AC	PB	PB	AAM	PRELIMINARY		0	27.01.15
			APPROVED	REVIEWED	CHECKED	DRAWN	DESCRIPTION	RELEASE STATUS	REV.	DATE

INSTRUMENT INSTALLATION DIAGRAM

PANKI THERMAL POWER STATION
1 x 660 MW UNIT
KANPUR (UP)

UTTAR PRADESH RAJYA VIDYUT UTPADAN NIGAM LIMITED

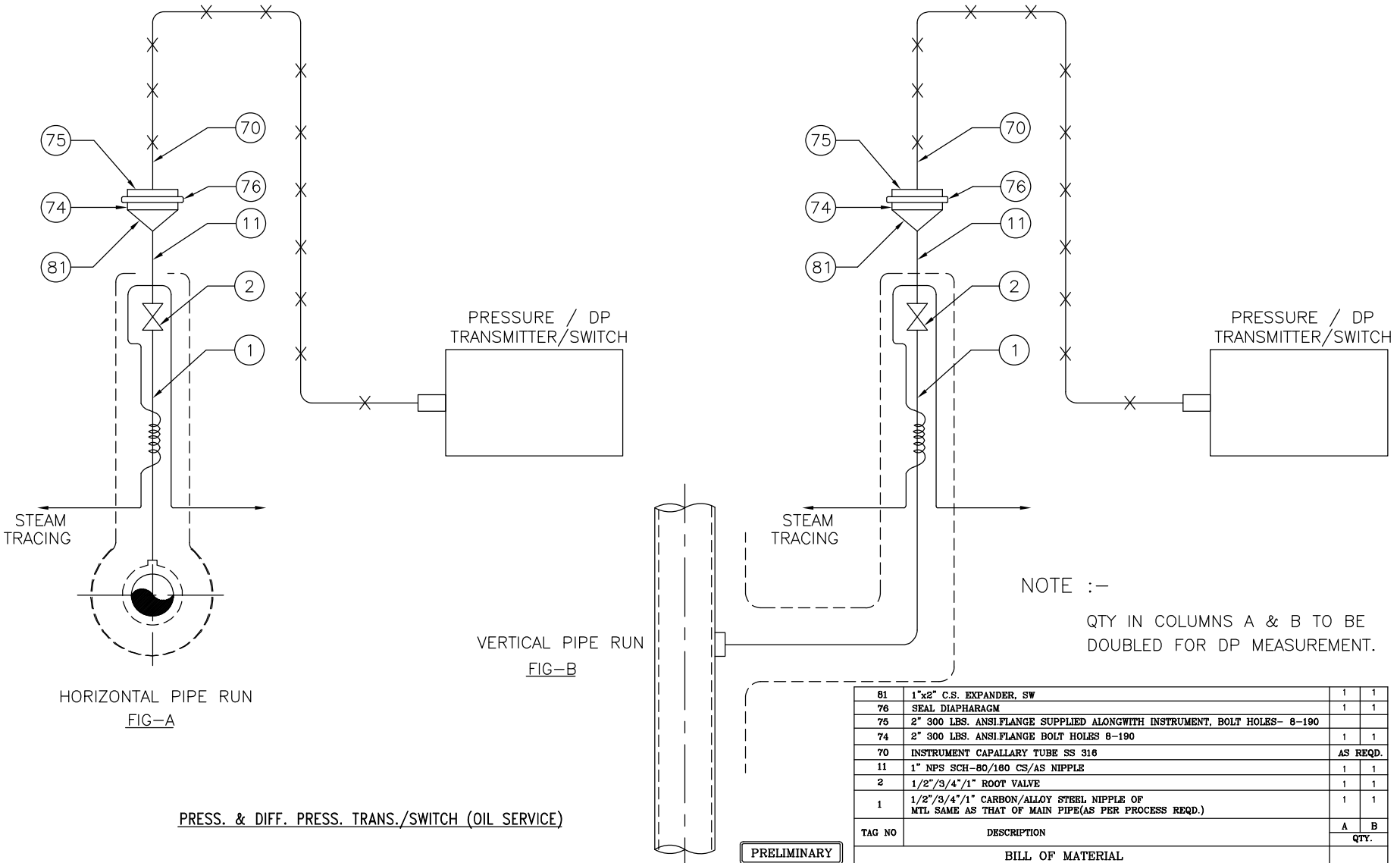
DEVELOPMENT CONSULTANTS PVT. LTD
CONSULTING ENGINEERS

JOB NO. 14A14 | SCALE : NIL

DWG. NO. 14A14-DWG-I-0010 | SHT. 3 OF 19 | REV. 0

FILE NAME 14A14-DWG-I-0010-R0

A3 (9-96) [420x297]



PRESS. & DIFF. PRESS. TRANS./SWITCH (OIL SERVICE)

PRELIMINARY

TAG NO	DESCRIPTION	A QTY.	B QTY.
81	1"x2" C.S. EXPANDER, SW	1	1
76	SEAL DIAPHARAGM	1	1
75	2" 300 LBS. ANSI.FLANGE SUPPLIED ALONGWITH INSTRUMENT, BOLT HOLES– 8–190		
74	2" 300 LBS. ANSI.FLANGE BOLT HOLES 8–190	1	1
70	INSTRUMENT CAPALLARY TUBE SS 316	AS REQD.	
11	1" NPS SCH–80/160 CS/AS NIPPLE	1	1
2	1/2"/3/4"/1" ROOT VALVE	1	1
1	1/2"/3/4"/1" CARBON/ALLOY STEEL NIPPLE OF MTL SAME AS THAT OF MAIN PIPE(AS PER PROCESS REQD.)	1	1

BILL OF MATERIAL

REVIEWED	APPROVED	REVIEWED	CHECKED	DRAWN	DESCRIPTION	RELEASE STATUS	REV.	DATE
	AC	PB	PB	AAM	PRELIMINARY		0	27.01.15

INSTRUMENT INSTALLATION DIAGRAM

PANKI THERMAL POWER STATION
1 x 660 MW UNIT
KANPUR (UP)

UTTAR PRADESH RAJYA VIDYUT
UTPADAN NIGAM LIMITED

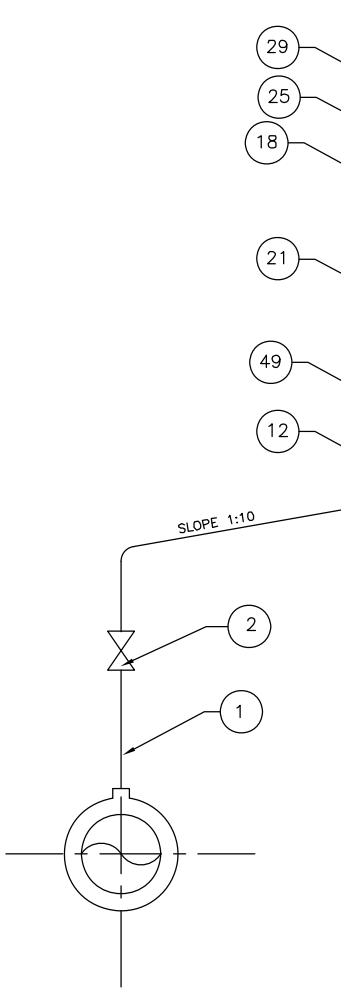
DEVELOPMENT CONSULTANTS PVT. LTD
CONSULTING ENGINEERS

JOB NO. 14A14 | SCALE : NIL

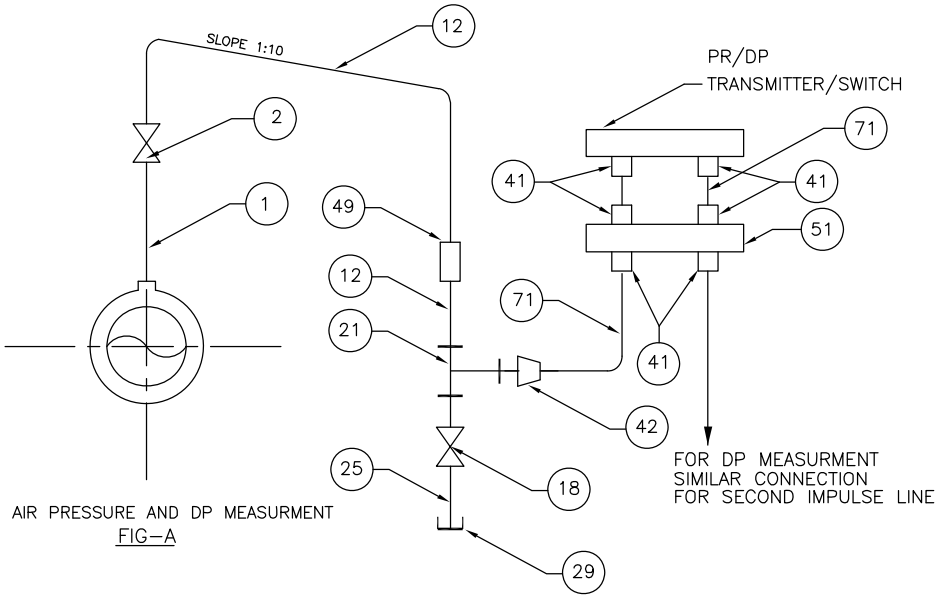
DWG. NO. 14A14–DWG–I–0010 | SHT. 4 OF 19 | REV. 0

FILE NAME D 14A14–DWG–I–0010–R0

A3 (9–96) [420x297]



AIR PRESSURE AND DP MEASURMENT
FIG–B



AIR PRESSURE AND DP MEASURMENT
FIG–A

TAG NO.	DESCRIPTION	AS REQD. A	AS REQD. B
		QTY.	
71	1/2"OD IMPULSE TUBE,SS–316	AS REQD.	
51	5/3/2–VALVE MANIFOLDS,SS–316	1	1
49	3/4"SW,CS/AS BULK HEAD PIPE UNION	1	1
42	3/4"BW X 1/2"OD TUBE FITTING,SS–316	1	1
41	1/2"NPT(M) X 1/2"00 TUBE COMPRESSION FITTING,SS–316	6	6
29	3/4"NPT(F) CS CAP	1	1
25	3/4"NPS,SCH–80 X 3/4"NPS(M)CS NIPPLE	1	1
21	3/4" EQUAL TEE,CS	1	1
18	3/4" SW,CS GLOBE VALVE	–	1
12	3/4" NPS. SCH–80 CARBON STEEL PIPE	AS REQD.	
2	1/2"/3/4"/1" ROOT VALVE – SW GLOBE VALVE	1	1
1	1/2"/3/4"/1" CARBON/ALLOY STEEL NIPPLE OF MTL. SAME AS THAT OF MAIN PIPE(AS PER PROCESS REQD.)	AS REQD.	

BILL OF MATERIAL

NOTE:–
QUANTITY IN COLUMN A&B TO BE DOUBLED
FOR DP TAPPING EXCEPT ITEM NO. 51

PRESS. & DIFF. PRESS. TRANS./SWITCH (AIR SERVICE)

PRELIMINARY

REVIEWED											
			AC	PB	PB	AAM	PRELIMINARY		0	27.01.15
			APPROVED	REVIEWED	CHECKED	DRAWN	DESCRIPTION	RELEASE STATUS	REV.	DATE

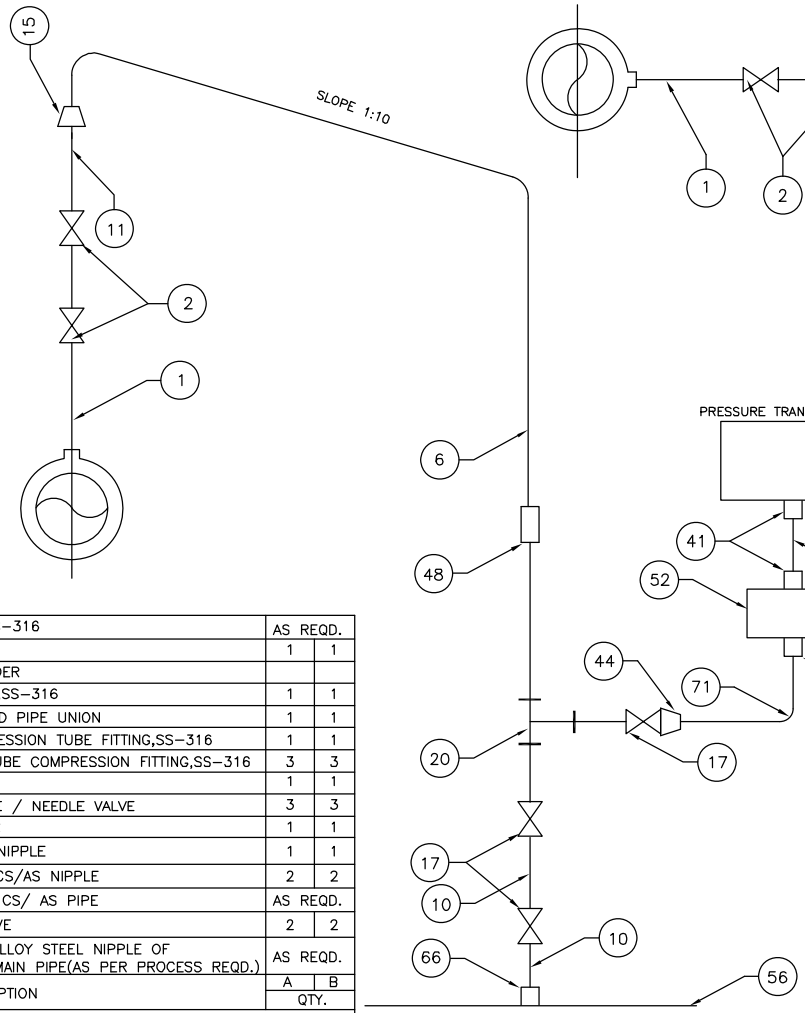
INSTRUMENT INSTALLATION DIAGRAM
PANKI THERMAL POWER STATION
1 x 660 MW UNIT
KANPUR (UP)
UTTAR PRADESH RAJYA VIDYUT UTPADAN NIGAM LIMITED

DEVELOPMENT CONSULTANTS PVT. LTD
CONSULTING ENGINEERS

JOB NO.	14A14	SCALE :	NIL
DWG. NO.	14A14–DWG–I–0010	SHT.	REV.
		5 OF 19	0

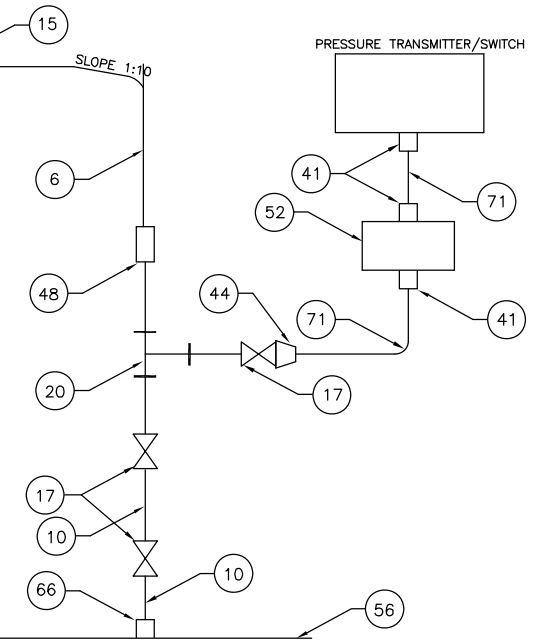
FILE NAME 14A14–DWG–I–0010–R0

A3 (9–96) [420x297]



TRANSMITTER MOUNTED BELOW
INSTRUMENT SOURCE POINT

FIG–A



TRANSMITTER MOUNTED BELOW
INSTRUMENT SOURCE POINT

FIG–B

TAG NO.	DESCRIPTION	QTY. A	QTY. B
71	1/2"OD IMPULSE TUBE,SS–316	AS REQD.	
66	1/2" GI SOCKET	1	1
56	5/3/2"NB GI DRAIN HEADER		
52	5/3/2–VALVE MANIFOLDS,SS–316	1	1
48	1/2"SW,CS/AS BULK HEAD PIPE UNION	1	1
44	1/2"BW X 1/2"OD COMRESSION TUBE FITTING,SS–316	1	1
41	1/2"NPT(M) X 1/2"OD TUBE COMPRESSION FITTING,SS–316	3	3
20	1/2"SW EQUAL TEE,CS	1	1
17	1/2" SW,CS GLOBE VALVE / NEEDLE VALVE	3	3
15	1" TO 1/2" SW REDUCER	1	1
11	1" NPS SCH–80 CS/AS NIPPLE	1	1
10	1/2" NPS,SCH 80/160, CS/AS NIPPLE	2	2
6	1/2" NPS. SCH–80/160 CS/ AS PIPE	AS REQD.	
2	1/2"/3/4"/1" ROOT VALVE	2	2
1	1/2"/3/4"/1" CARBON/ALLOY STEEL NIPPLE OF MTL. SAME AS THAT OF MAIN PIPE(AS PER PROCESS REQD.)	AS REQD.	

BILL OF MATERIAL

NOTE:–

1. FOR HIGH TEMP. SERVICE (MORE THAN °80C) A 'U'–TUBE / SYPHON (REF. SH–2 OF 19) SHALL BE PROVIDED BETWEEN THE MANIFOLD AND THE TRANSMITTER/SWITCH
2. WITH ROOT VLV. OF SIZE 1/2"SW NIPPLE PIECE AND 1 TO 1/2"SW REDUCER IS NOT REQUIERED
3. FOR HIGH PR.(MORE THAN 40Kg/sqcm) ONE ISOLATING VLV. IS PROVIDED IN EACH LINE BETWEEN VLV. MANIFOLD AND 1/2"SW EQUAL TEE AND 2.NOS DRAIN VLV. ARE ALSO PROVIDED.

PRELIMINARY

PRESS. & DIFF. PRESS. TRANS./SWITCH (STEAM & LIQUID SERVICE)

REVIEWED										
			AC	PB	PB	AAM	PRELIMINARY		0	27.01.15
			APPROVED	REVIEWED	CHECKED	DRAWN	DESCRIPTION	RELEASE STATUS	REV.	DATE

INSTRUMENT INSTALLATION DIAGRAM

PANKI THERMAL POWER STATION
1 x 660 MW UNIT
KANPUR (UP)

UTTAR PRADESH RAJYA VIDYUT UTPADAN NIGAM LIMITED

DEVELOPMENT CONSULTANTS PVT. LTD
CONSULTING ENGINEERS

JOB NO. 14A14 | SCALE : NIL

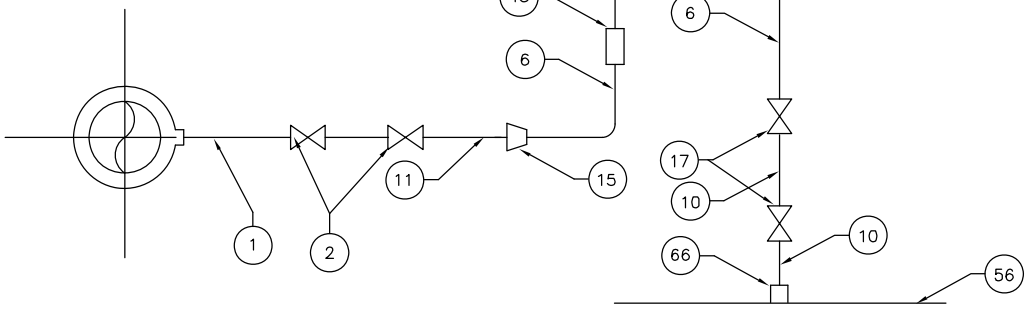
DWG. NO. 14A14–DWG–I–0010 | SHT. 6 OF 19 | REV. 0

FILE NAME 14A14–DWG–I–0010–R0

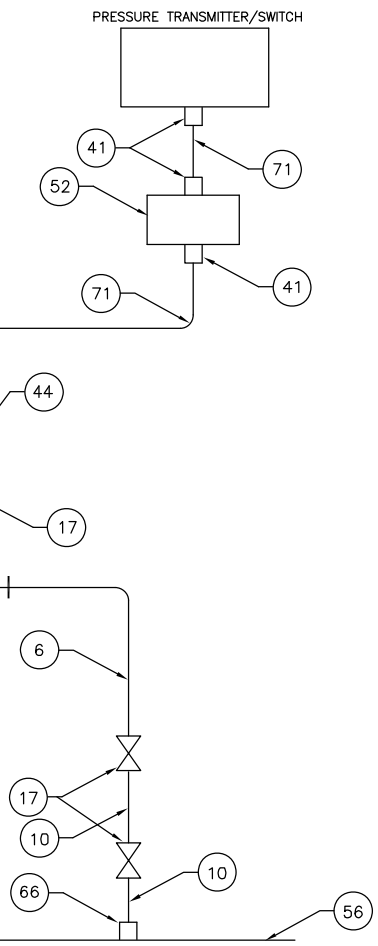
A3 (9–96) [420x297]

TAG NO.	DESCRIPTION	AS REQD. QTY. C	D
71	1/2"OD IMPULSE TUBE,SS-316	AS REQD.	
66	1/2" GI SOCKET	1	1
56	2"NB GI DRAIN HEADER		
52	5/3/2-VALVE MANIFOLDS,SS-316	1	1
48	1/2"SW,CS/AS BULK HEAD PIPE UNION	1	1
44	1/2"BW X 1/2"OD COMRESSION TUBE FITTING,SS-316	1	1
41	1/2"NPT(M) X 1/2"OD TUBE COMPRESSION FITTING,SS-316	3	3
20	1/2"SW EQUAL TEE,CS	1	1
17	1/2" SW,CS GLOBE VALVE / NEEDLE VALVE	3	3
15	1" TO 1/2" SW REDUCER	1	1
11	1" NPS SCH-80 CS/AS NIPPLE	1	1
10	1/2" NPS,SCH 80/160, CS/AS NIPPLE	2	2
6	1/2" NPS. SCH-80/160 CS/ AS PIPE	AS REQD.	
2	1/2"/3/4"/1" ROOT VALVE	2	2
1	1/2"/3/4"/1" CARBON/ALLOY STEEL NIPPLE OF MTL. SAME AS THAT OF MAIN PIPE(AS PER PROCESS REQD.)	AS REQD.	

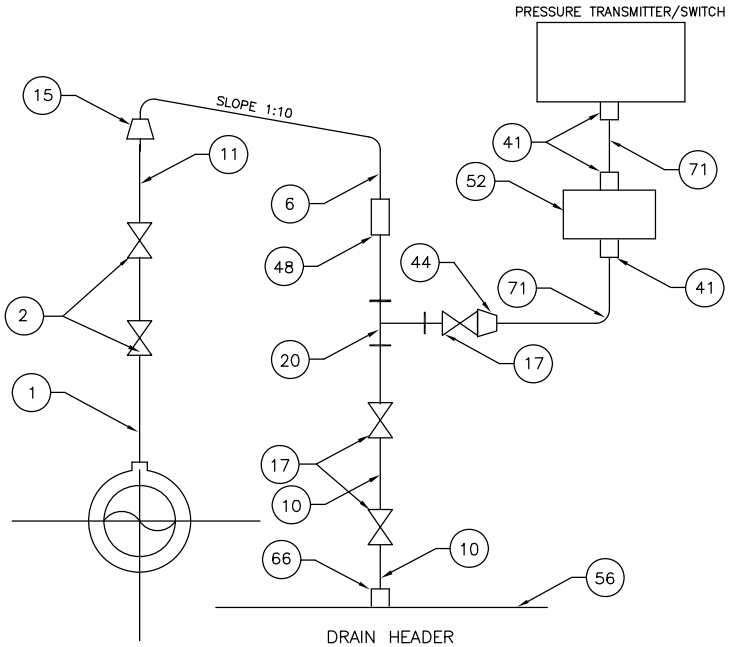
BILL OF MATERIAL



PRESS. & DIFF.PRESS. TRANSMITTERS/SWITCH
(STEAM & LIQUID SERVICE)



TRANSMITTER MOUNTED ABOVE
INSTRUMENT SOURCE POINT
FIG-D



TRANSMITTER MOUNTED ABOVE
INSTRUMENT SOURCE POINT
FIG-C

NOTE:-
1. FOR HIGH TEMP. SERVICE (MORE THAN °80C) A 'U'-TUBE / SYPHON (REF. SH-2 OF 19)SHALL BE PROVIDED BETWEEN THE MANIFOLD AND THE TRANSMITTER/SWITCH
2. WITH ROOT VLV. OF SIZE 1/2"SW NIPPLE PIECE AND 1 TO 1/2"SW REDUCER IS NOT REQUIERED
3. FOR HIGH PR.(MORE THAN 40Kg/sqcm) ONE ISOLATING VLV. IS PROVIDED IN EACH LINE BETWEEN VLV. MANIFOLD AND 1/2"SW EQUAL TEE AND 2.NOS DRAIN VLV. ARE ALSO PROVIDED.

PRELIMINARY

REVIEWED	APPROVED	REVIEWED	CHECKED	DRAWN	DESCRIPTION	RELEASE STATUS	REV.	DATE
	AC	PB	PB	AAM	PRELIMINARY		0	27.01.15

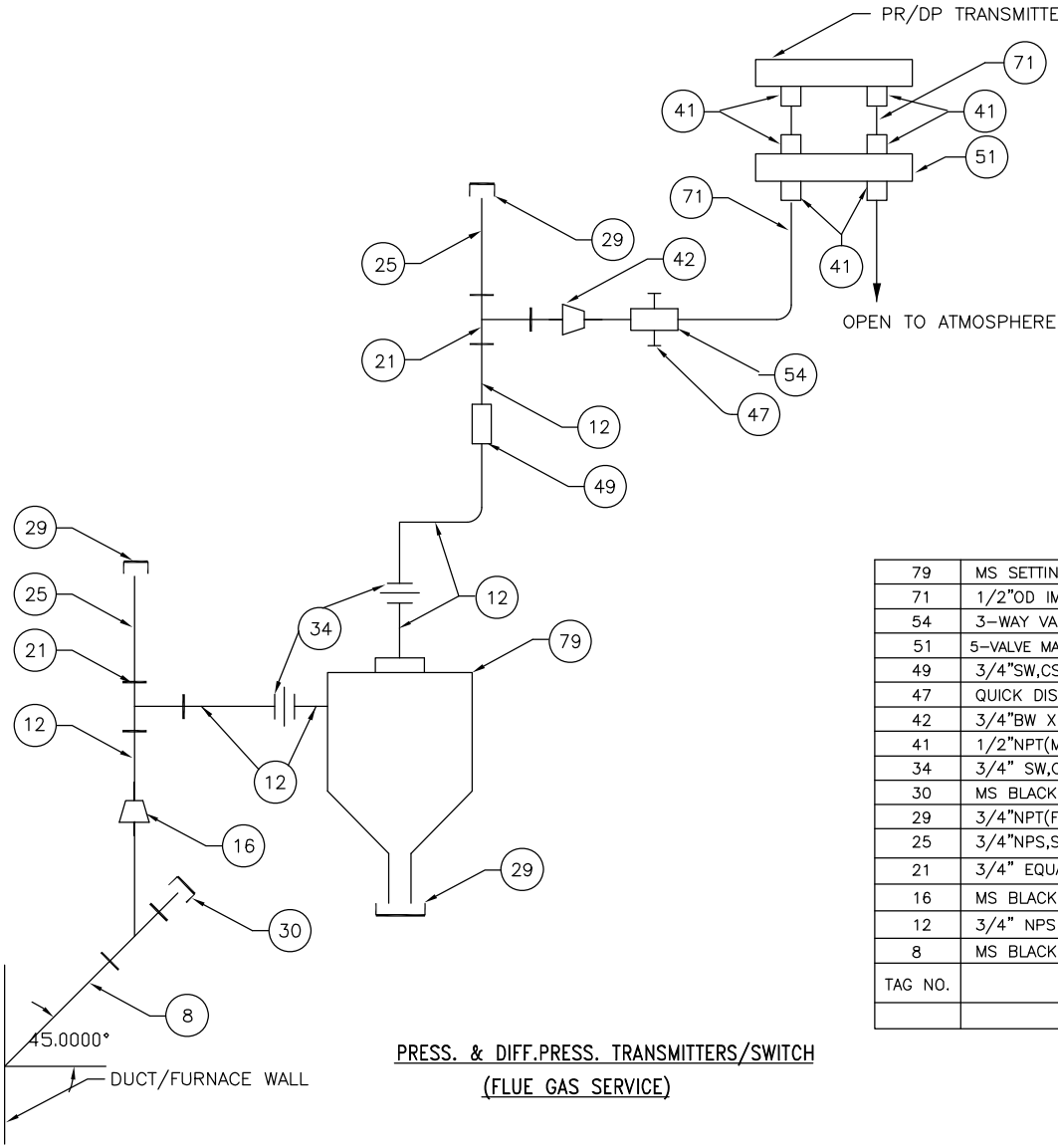
INSTRUMENT INSTALLATION DIAGRAM
PANKI THERMAL POWER STATION
1 x 660 MW UNIT
KANPUR (UP)
UTTAR PRADESH RAJYA VIDYUT UTPADAN NIGAM LIMITED

DEVELOPMENT CONSULTANTS PVT. LTD
CONSULTING ENGINEERS

JOB NO. 14A14 | SCALE : NIL
DWG. NO. 14A14-DWG-I-0010 | SHT. 7 OF 19 | REV. 0

FILE NAME 14A14-DWG-I-0010-R0

A3 (9-96) [420x297]



NOTE:–
FOR DP TRANSMITTERTHE SECOND IMPULSE LINE
SHALL BE CONNECTED SIMILARTO FIRST IMPULSE LINE

TAG NO.	DESCRIPTION	QTY.
	BILL OF MATERIAL	A
79	MS SETTING CHAMBER 16" X 10"ø	1
71	1/2"OD IMPULSE TUBE,SS–316	AS REQD.
54	3–WAY VALVE WITH 1/2" SWAGE LOCK CONNECTION	1
51	5–VALVE MANIFOLDS/3–VALVE MANIFOLDS/2–VALVE MANIFOLDS,SS–316	1
49	3/4"SW,CS/AS BULK HEAD PIPE UNION	1
47	QUICK DISCONNECT FITTING,CS	1
42	3/4"BW X 1/2"OD TUBE FITTING,SS–316	1
41	1/2"NPT(M) X 1/2"00 TUBE COMPRESSION FITTING,SS–316	6
34	3/4" SW,CS PIPE UNION	2
30	MS BLACK PIPE CAP	1
29	3/4"NPT(F) CS CAP	3
25	3/4"NPS,SCH–80 X 3/4"NPT(M)CS NIPPLE	2
21	3/4" EQUAL TEE,CS	2
16	MS BLACK PIPE TO 3/4" SW,CS REDUCER	1
12	3/4" NPS SCH–80 CARBON STEEL PIPE	AS REQD.
8	MS BLACK PIPE	AS REQD.

PRESS. & DIFF.PRESS. TRANSMITTERS/SWITCH (FLUE GAS SERVICE)

PRELIMINARY

REVIEWED											
			AC	PB	PB	AAM	PRELIMINARY		0	27.01.15
			APPROVED	REVIEWED	CHECKED	DRAWN	DESCRIPTION	RELEASE STATUS	REV.	DATE

INSTRUMENT INSTALLATION DIAGRAM

PANKI THERMAL POWER STATION
1 x 660 MW UNIT
KANPUR (UP)

UTTAR PRADESH RAJYA VIDYUT UTPADAN NIGAM LIMITED

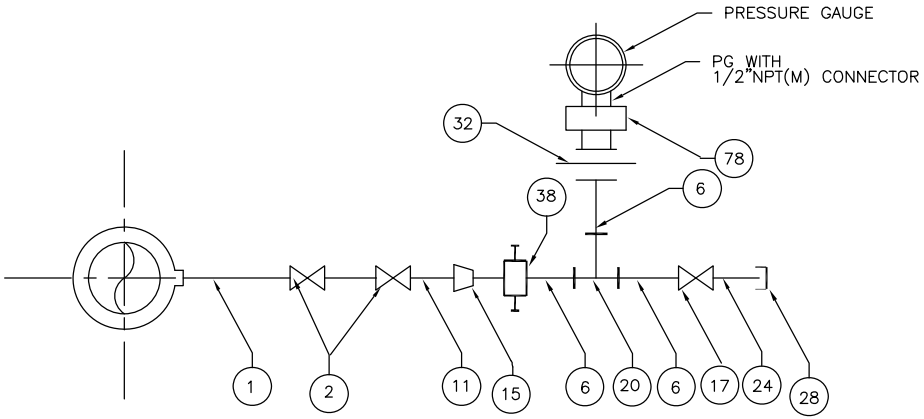
DEVELOPMENT CONSULTANTS PVT. LTD
CONSULTING ENGINEERS

JOB NO. 14A14 | SCALE : NIL

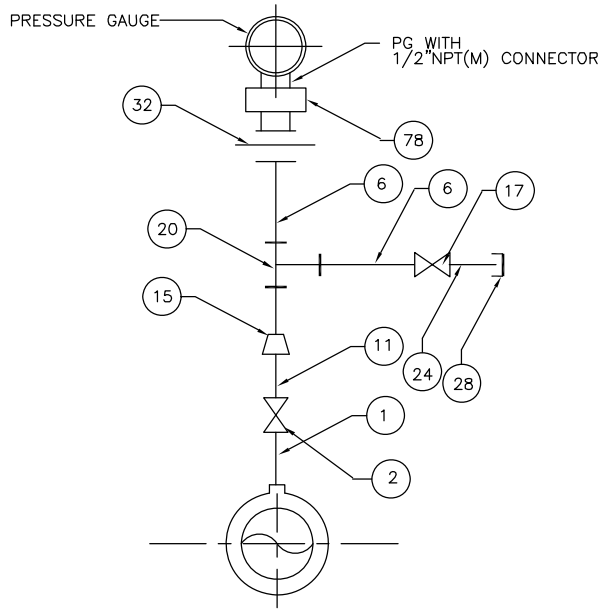
DWG. NO. 14A14–DWG–I–0010 | SHT. 8 OF 19 | REV. 0

FILE NAME 14A14–DWG–I–0010–R0

A3 (9–96) [420x297]



STEAM/LIQUID SERVICE
FIG–A



AIR SERVICE
FIG–B

TAG NO.	DESCRIPTION	QTY. A	QTY. B
78	1/2"NPT(F)X1/2"NPT(M) SNUBBER/PULSATION DAMPER	1	1
59	1/2"SW, STRAIGHT PIPE CONNECTOR, CS/AS	–	–
38	3 WAY GAUGE VALVE 1/2" NB SW	1	–
37	6" COILED SYPHON SCH 80/160 1/2"NB CS/SS	–	–
32	1/2"NPS,3PIECE PIPE UNION WITH 1/2"NPT(F) SCREWED	1	1
28	1/2"NPT (F) CS CAP	1	1
24	1/2"NPS,SCH–80/160X1/2"NPT(M)CS/AS NIPPLE	1	1
20	1/2"SW EQUAL TEE, CS/AS	1	1
17	1/2" SW CS/AS GLOBE VALVE	1	1
15	1" TO 1/2" SOCKET WELDED REDUCER	1	1
11	1" NPS SCH–80/160 CS/AS NIPPLE	1	1
6	1/2" NPS. SCH–80/160 CS/ AS PIPE	AS REQD.	
2	1/2"/3/4"/1" ROOT VALVE–SW GLOBE VALVE	2	1
1	1/2"/3/4"/1" CARBON/ALLOY STEEL NIPPLE OF MTL. SAME AS THAT OF MAIN PIPE(AS PER PROCESS REQD.)	AS REQD.	

BILL OF MATERIAL

LOCAL PRESSURE GAUGE

PRELIMINARY

REVIEWED										
			AC	PB	PB	AAM	PRELIMINARY		0	27.01.15
			APPROVED	REVIEWED	CHECKED	DRAWN	DESCRIPTION	RELEASE STATUS	REV.	DATE

INSTRUMENT INSTALLATION DIAGRAM

PANKI THERMAL POWER STATION
1 x 660 MW UNIT
KANPUR (UP)

UTTAR PRADESH RAJYA VIDYUT UTPADAN NIGAM LIMITED

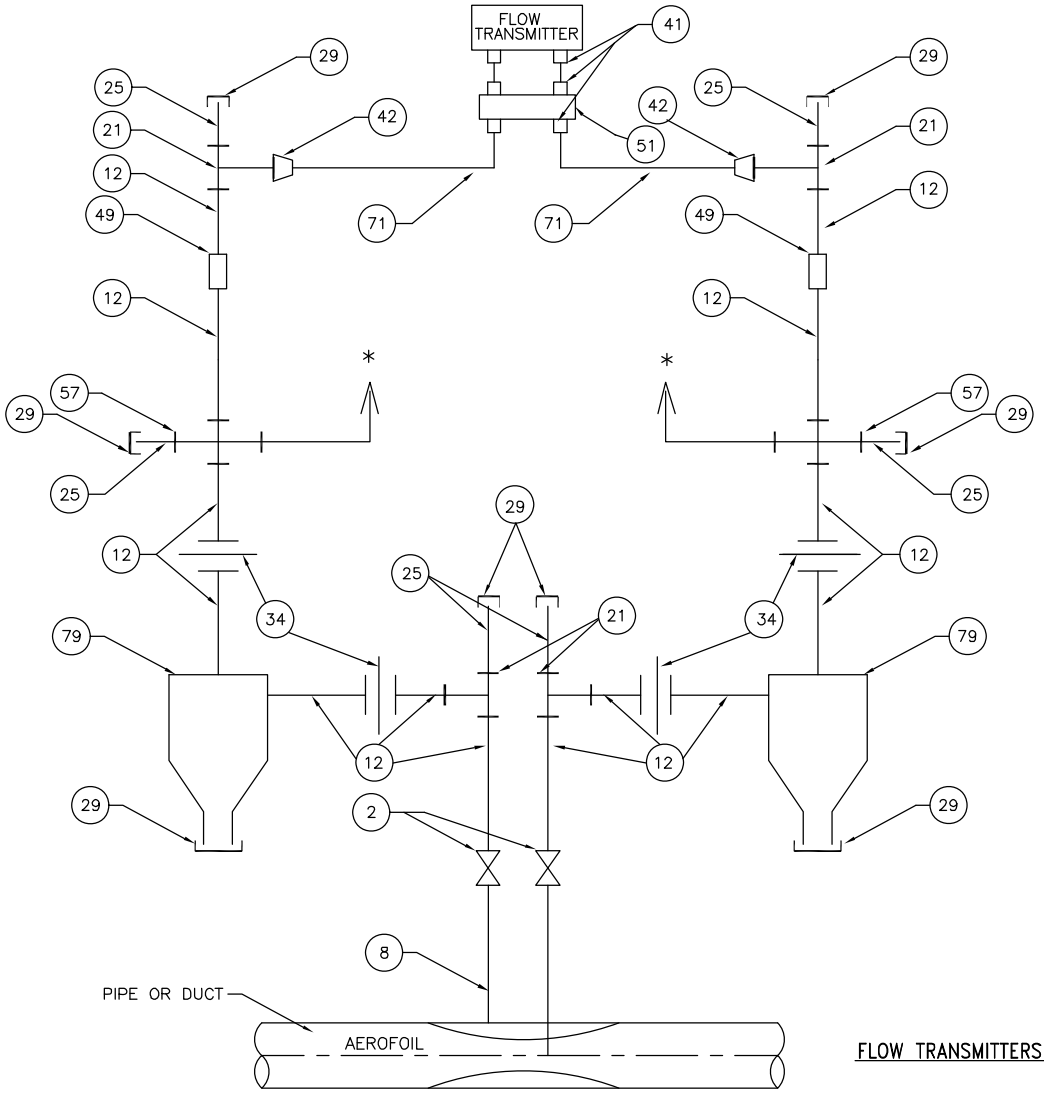
DEVELOPMENT CONSULTANTS PVT. LTD
CONSULTING ENGINEERS

JOB NO. 14A14 | SCALE : NIL

DWG. NO. 14A14–DWG–I–0010 | SHT. 9 OF 19 | REV. 0

FILE NAME 14A14–DWG–I–0010–R0

A3 (9–96) [420x297]



TAG NO.	DESCRIPTION	QTY.
79	MS SETTLING CHAMBER 16" X 10"ø	2
71	1/2"OD IMPULSE TUBE SS-316	AS REQD.
57	3/4"SW EQUAL CROSS, 3000lbs	2
51	5-VALVE MANIFOLDS	1
49	3/4"SW CS/AS BULK HEAD PIPE UNION	2
42	3/4"BW X 1/2"OD TUBE FITTING, SS-316	2
41	1/2" NPT (M) X 1/2"OD TUBE COMPRESSION FITTING,SS-316	6
34	3/4" SW,CS PIPE UNION	4
29	3/4" NPT (F) CS,CAP	8
25	3/4" NPS SCH-80 X 3/4" NPT (M) CS NIPPLE	6
21	3/4" SOCKET WELDED EQUAL TEE CS	4
12	3/4" NPS 80 CARBON STEEL PIPE	AS REQD.
2	1/2"/3/4"/1" ROOT VALVE-SW GLOBE VALVE	2
8	MS BLACK PIPE	AS REQD.

NOTE:-
* TO BULK HEAD UNION OF FLOW TRANSMITTER NO. II

FLOW TRANSMITTERS (AIR SERVICE)

PRELIMINARY

REVIEWED											
			AC	PB	PB	AAM	PRELIMINARY		0	27.01.15
			APPROVED	REVIEWED	CHECKED	DRAWN	DESCRIPTION	RELEASE STATUS	REV.	DATE

INSTRUMENT INSTALLATION DIAGRAM

PANKI THERMAL POWER STATION
1 x 660 MW UNIT
KANPUR (UP)

UTTAR PRADESH RAJYA VIDYUT UTPADAN NIGAM LIMITED

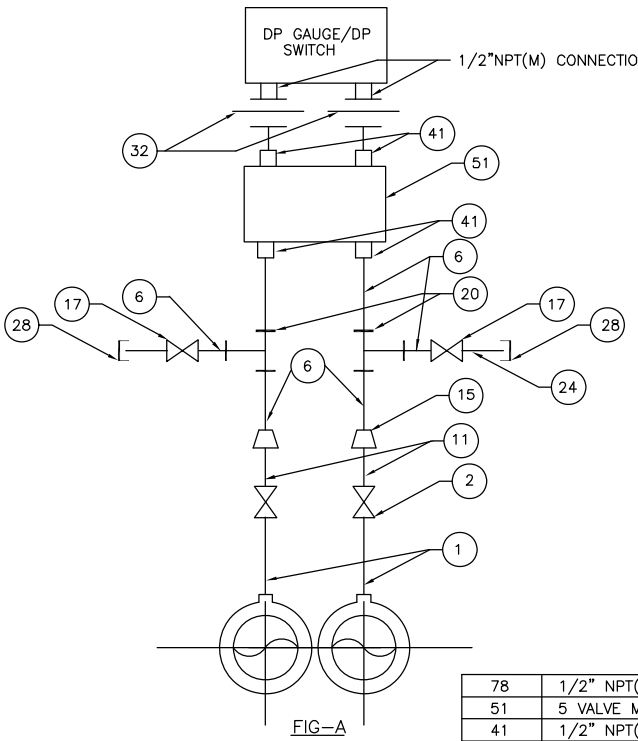
DEVELOPMENT CONSULTANTS PVT. LTD
CONSULTING ENGINEERS

JOB NO. 14A14 | SCALE : NIL

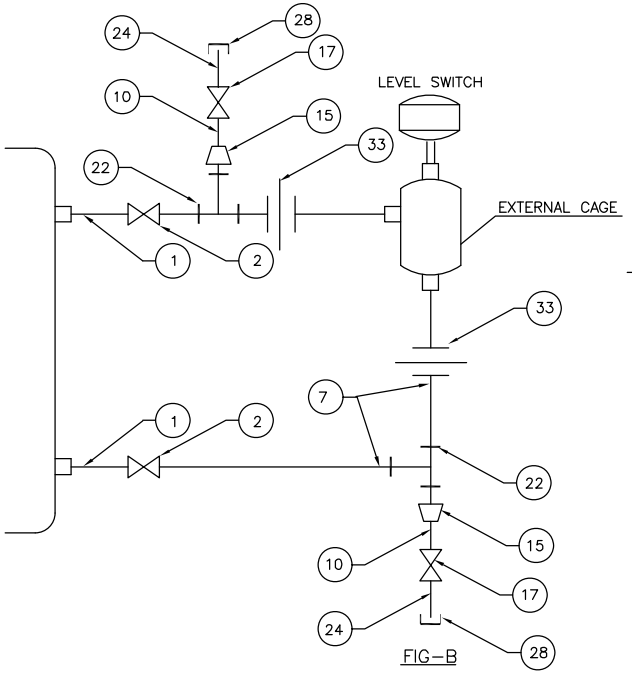
DWG. NO. 14A14-DWG-I-0010 | SHT. 10 OF 19 | REV. 0

FILE NAME 14A14-DWG-I-0010-R0

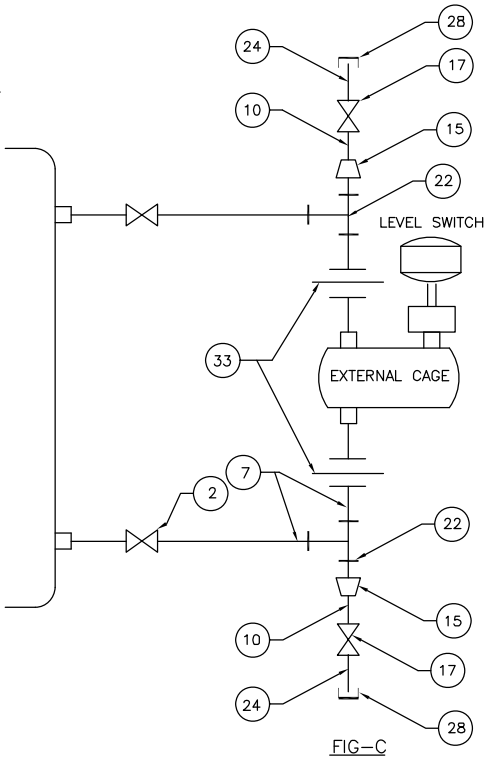
A3 (9-96) [420x297]



FIG–A



FIG–B



FIG–C

DIFF. PRESS. SWITCH/GAUGE/LEVEL SWITCHES

TAG NO.	DESCRIPTION	QTY. A	QTY. B	QTY. C
78	1/2" NPT(F) X 1/2" NPT(M) SNUBBER/PULSATION DAMPNER	1	–	–
51	5 VALVE MANIFOLDS, SS–316	–	–	–
41	1/2" NPT(M) X 1/2" OD TUBE COMPRESSION FITTING,SS–316	–	–	–
38	3 WAY GAUGE VALVE 1/2"NB SW	1	–	–
33	1" SW EQUAL PIPE UNION	–	2	2
32	1/2" NPS,3 PIECE PIPE UNION 1/2" NPT(F) SCREWED AND 1/2" SW CONNECTION	1	–	–
28	1/2" NPT(F) CS. CAP	1	2	2
24	1/2" NPS,SCH 80/160 X 1/2" NPT(M) CS/AS NIPPLE	1	2	2
22	1" SW EQUAL TEE CS/AS	–	1	2
20	1/2"SW EQUAL TEE CS/AS	1	–	–
17	1/2" SW,CS/AS, GLOBE VALVE	1	2	2
15	1" TO 1/2" SOCKET WELD REDUCER	1	2	2
11	1"NPS SCH 80/160 CS/AS NIPPLE	1	–	–
10	1/2"NPS,SCH 80/160 CA/AS NIPPLE	–	2	2
6	1/2"NPS,SCH 80/160 CARBON/ALLOY STEEL PIPE	AS REQD.		
7	1" NPS,SCH 80/160 CS/AS STEEL PIPE	AS REQD.		
2	1/2"3/4"/1" ROOT VALVE – SW GLOBE VALVE	2	2	2
1	1/2"/3/4"/1" CARBON/ALLOY STEEL NIPPLE OF MTL SAME AS THAT OF MAIN PIPE (AS PER PROCESS REQD.)	AS REQD.		

NOTE:–

WITH VALVE OF SIZE 1/2"SW NIPPLE PIECE IS NOT REQUIERED

PRELIMINARY

REVIEWED										
			AC	PB	PB	AAM	PRELIMINARY		0	27.01.15
			APPROVED	REVIEWED	CHECKED	DRAWN	DESCRIPTION	RELEASE STATUS	REV.	DATE

INSTRUMENT INSTALLATION DIAGRAM

PANKI THERMAL POWER STATION
1 x 660 MW UNIT
KANPUR (UP)

UTTAR PRADESH RAJYA VIDYUT UTPADAN NIGAM LIMITED

DEVELOPMENT CONSULTANTS PVT. LTD
CONSULTING ENGINEERS

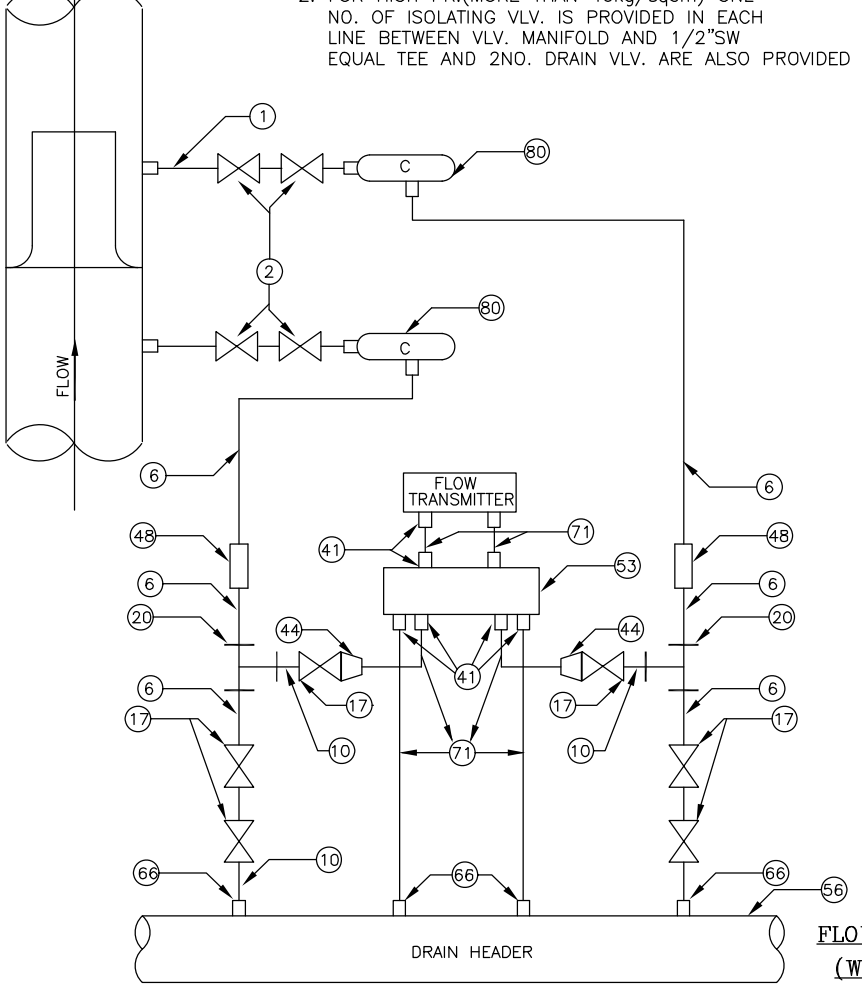
JOB NO. 14A14 | SCALE : NIL

DWG. NO. 14A14–DWG–I–0010 | SHT. 11 OF 19 | REV. 0

FILE NAME 14A14–DWG–I–0010–R0

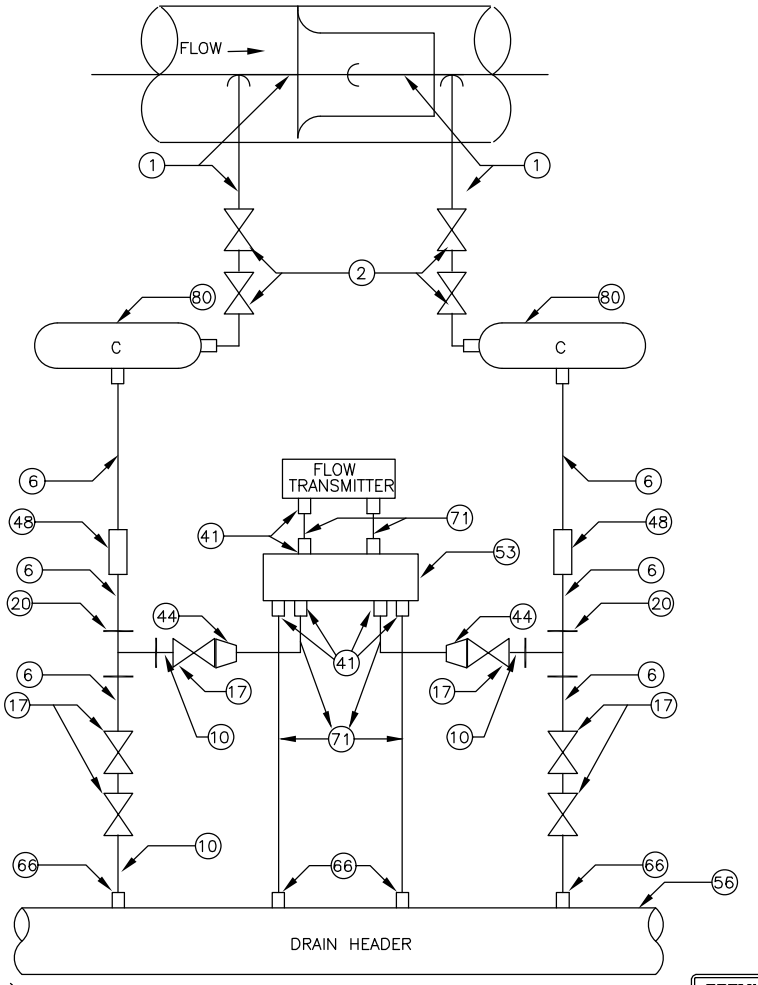
A3 (9–96) [420x297]

NOTE:–
1. FOR HIGH TEMP. SERVICE (MORE THAN 80°C) A 'U' TUBE(REF. SH–2 OF 19) SHALL BE PROVIDED BETWEEN THE MANIFOLD AND THE TRANSMITTER
2. FOR HIGH PR.(MORE THAN 40kg/sqcm) ONE NO. OF ISOLATING VLV. IS PROVIDED IN EACH LINE BETWEEN VLV. MANIFOLD AND 1/2"SW EQUAL TEE AND 2NO. DRAIN VLV. ARE ALSO PROVIDED



HORIZONTAL PIPE RUN (FIG–A)

FLOW TRANS. (WATER & STEAM SERVICE)



VERTICAL PIPE RUN (FIG–B)

PRELIMINARY

REVIEWED										
			AC	PB	PB	AAM	PRELIMINARY		0	27.01.15
			APPROVED	REVIEWED	CHECKED	DRAWN	DESCRIPTION	RELEASE STATUS	REV.	DATE

INSTRUMENT INSTALLATION DIAGRAM

PANKI THERMAL POWER STATION
1 x 660 MW UNIT
KANPUR (UP)

UTTAR PRADESH RAJYA VIDYUT UTPADAN NIGAM LIMITED

DEVELOPMENT CONSULTANTS PVT. LTD
CONSULTING ENGINEERS

JOB NO. 14A14 | SCALE : NIL

DWG. NO. 14A14–DWG–I–0010 | SHT. 12A OF 19 | REV. 0

FILE NAME 14A14–DWG–I–0010–R0

A3 (9–96) [420x297]

BILL OF MATERIAL
FOR FLOW TRANS.(WATER & STEAM SERVICE)

80	CONDENSATION CHAMBER	2	2
71	1/2"OD IMPULSE TUBE, SS-316	AS REQD.	
66	1/2" GI SOCKET / FUNNEL	4	4
56	2"NB GI DRAIN HEADER	AS REQD.	
53	5-VALVE MANIFOLD, SS-316	1	1
48	1/2" SW, CS/AS BULK HEAD PIPE UNION	2	2
44	1/2"BWX1/2"OD COMPRESSION TUBE FITTING,SS-316	2	2
41	1/2"NPT(M)X1/2"OD TUBE COMPRESSION FITTING,SS-316	8	8
10	1/2" NPS SCH 80/160,CS/AS NIPPLE	4	4
20	1/2" SOCKET WELDED EQUAL TEE CS/AS	2	2
17	1/2" SOCKET WELDED CS GLOBE VALVE	6	6
6	1/2" NPS SCH 80/160 CS/AS PIPE	AS REQD.	
2	1/2" SOCKET WELDED GLOBE VALVE	4	4
1	1/2" NPS SCH 80 NIPPLES OF MATERIAL SAME AS MAIN PIPE WITH NECESSARY ATTACH TO FLANGES	AS REQD.	
TAG NO.	DESCRIPTION	A	B

PRELIMINARY

REVIEWED											
			AC	PB	PB	AAM	PRELIMINARY		0	27.01.15	
			APPROVED	REVIEWED	CHECKED	DRAWN	DESCRIPTION	RELEASE STATUS	REV.	DATE	

INSTRUMENT INSTALLATION DIAGRAM

PANKI THERMAL POWER STATION
1 x 660 MW UNIT
KANPUR (UP)

UTTAR PRADESH RAJYA VIDYUT UTPADAN NIGAM LIMITED

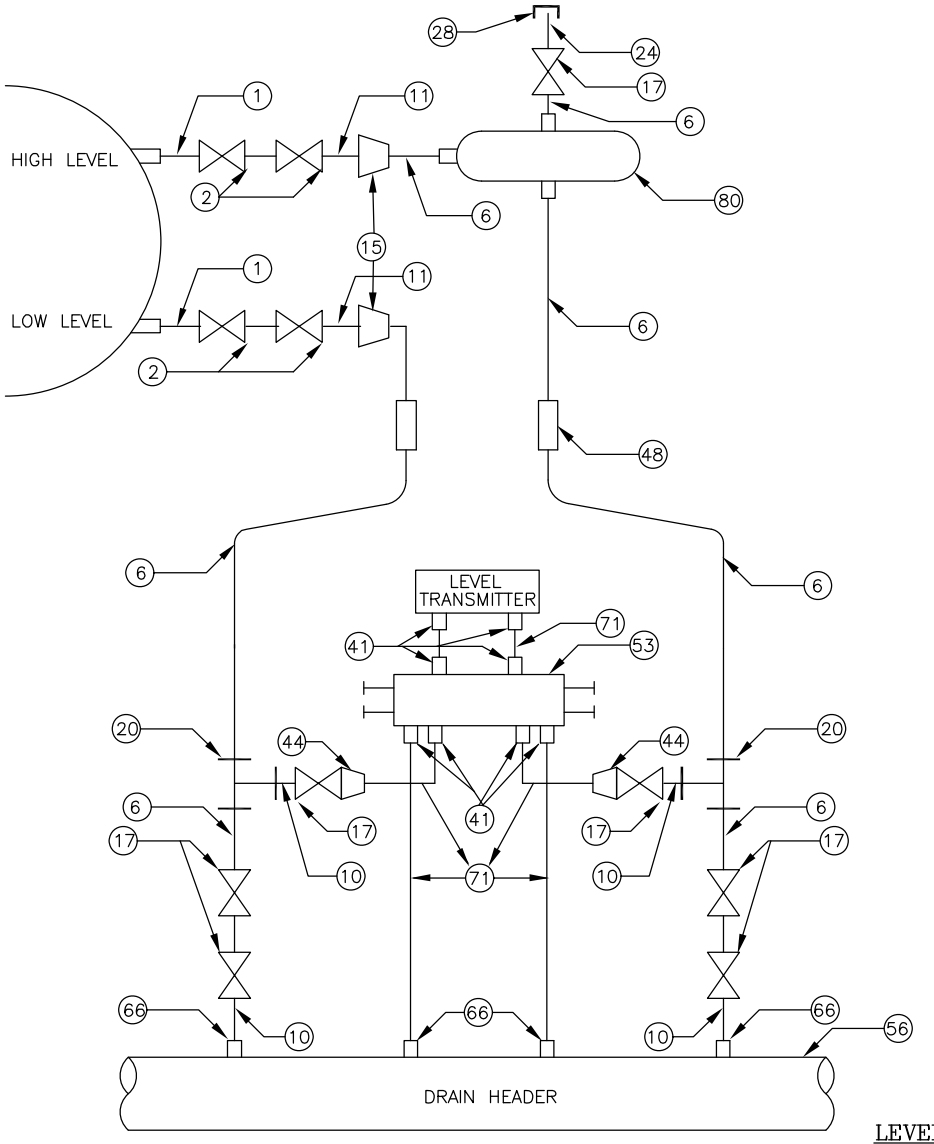
DEVELOPMENT CONSULTANTS PVT. LTD
CONSULTING ENGINEERS

JOB NO. 14A14 | SCALE : NIL

DWG. NO. 14A14-DWG-I-0010 | SHT. 12 OF 19 | REV. 0

FILE NAME 14A14-DWG-I-0010-R0

A3 (9-96) [420x297]



TRANSMITTER MOUNTED BELOW INST. SOURCE POINT

TAG NO.	DESCRIPTION	BOM
80	CONDENSATION CHAMBER	1
71	1/2"OD IMPULSE TUBE, SS-316	AS REQD.
66	1/2" GI SOCKET / FUNNEL	4
56	2"NB GI DRAIN HEADER	AS REQD.
53	5-VALVE MANIFOLD, SS-316	1
48	1/2" SW, CS/AS BULK HEAD PIPE UNION	2
44	1/2"BWX1/2"OD COMPRESSION TUBE FITTING,SS-316	2
41	1/2"NPT(M)X1/2"OD TUBE COMPRESSION FITTING,SS-316	8
28	1/2" NPT (F) CS CAP	1
24	1/2" NPS SCH-80/160X1/2"NPT(M) CS/AS NIPPLE	1
20	1/2" SOCKET WELDED EQUAL TEE CS/AS	2
17	1/2" SOCKET WELDED CS GLOBE VALVE	7
15	1"TO 1/2" SOCKET WELD REDUCER	2
11	1" NPS SCH 80/160 CS/AS NIPPLE	2
10	1/2" NPS SCH 80/160,CS/AS NIPPLE	4
6	1/2" NPS SCH 80/160 CS/AS PIPE	AS REQD.
2	1/2"/3/4"/1" SOCKET WELDED GLOBE VLV/ROOT VLV.	4
1	1/2" NPS SCH 80 NIPPLES OF MATERIAL SAME AS MAIN PIPE WITH NECESSARY ATTACH TO FLANGES	AS REQD.

NOTE:-
1. FOR HIGH TEMP. SERVICE (MORE THAN 80°C) A 'U' TUBE(REF. SH-2 OF 19) SHALL BE PROVIDED BETWEEN THE MANIFOLD AND THE TRANSMITTER
2. FOR HIGH PR.(MORE THAN 40kg/sqcm) ONE NO. OF ISOLATING VLV. IS PROVIDED IN EACH LINE BETWEEN VLV. MANIFOLD AND 1/2"SW EQUAL TEE AND 2NO. DRAIN VLV. ARE ALSO

LEVEL TRANSMITTERS

PRELIMINARY

REVIEWED										
			AC	PB	PB	AAM	PRELIMINARY		0	27.01.15
			APPROVED	REVIEWED	CHECKED	DRAWN	DESCRIPTION	RELEASE STATUS	REV.	DATE

INSTRUMENT INSTALLATION DIAGRAM

PANKI THERMAL POWER STATION
1 x 660 MW UNIT
KANPUR (UP)

UTTAR PRADESH RAJYA VIDYUT UTPADAN NIGAM LIMITED

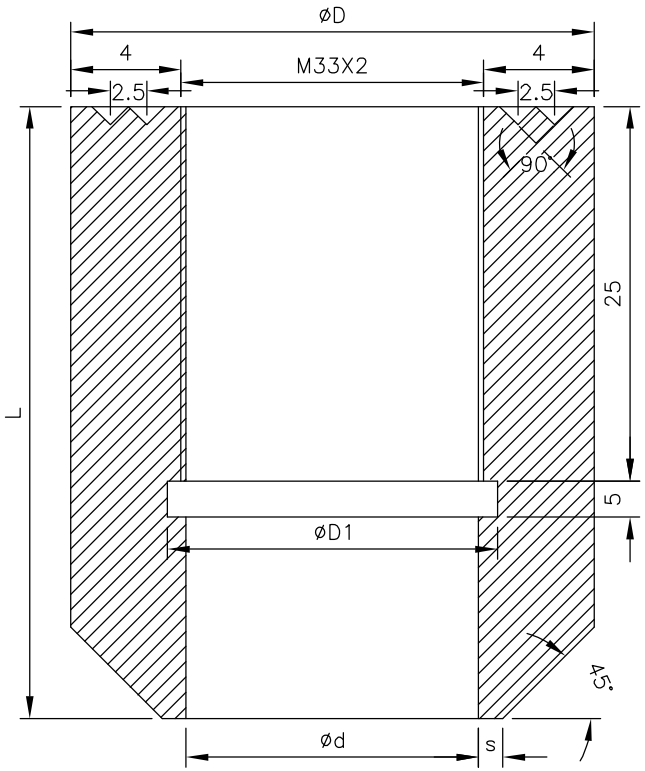
DEVELOPMENT CONSULTANTS PVT. LTD
CONSULTING ENGINEERS

JOB NO. 14A14 | SCALE : NIL

DWG. NO. 14A14-DWG-I-0010 | SHT. 13 OF 19 | REV. 0

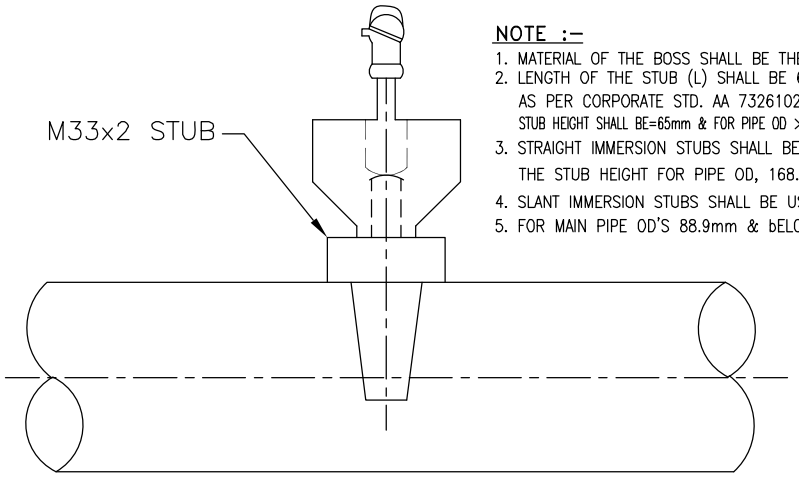
FILE NAME 14A14-DWG-I-0010-R0

A3 (9-96) [420x297]



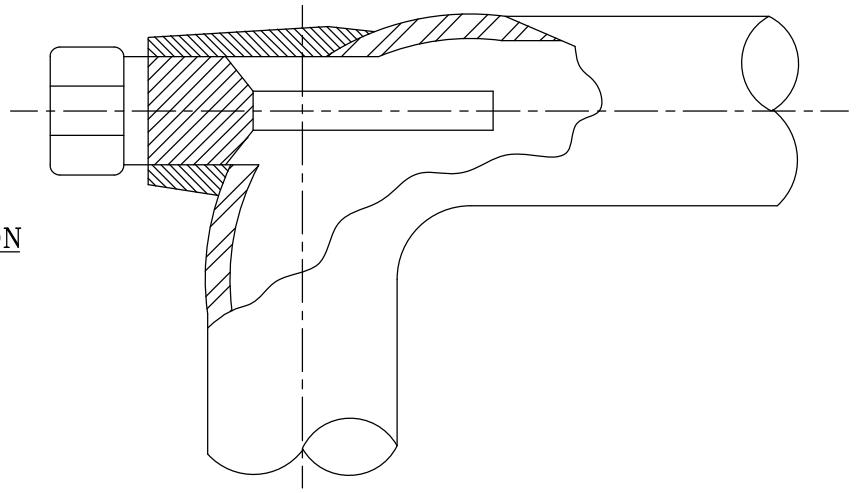
TEMPERATURE STUB FOR STRAIGHT IMMERSION

FOR PIPE OD BELOW 219.1mm	29	55	33.5	1.5	65
FOR PIPE OD 219.1mm & ABOVE	29	55	33.5	1.5	45
MAIN PIPE SIZES	d	D	D1	S	L



INSTALLATION TYPE-1

(FOR MAIN PIPE OD 168.3mm & ABOVE)



INSTALLATION TYPE-2

(FOR MAIN PIPE OD 88.9mm & BELOW)

NOTE :-

1. MATERIAL OF THE BOSS SHALL BE THE SAME AS THE PIPE INTO WHICH IT IS WELDED.
2. LENGTH OF THE STUB (L) SHALL BE 65/45 mm DEPENDING UPON PIPE SIZE, AS PER CORPORATE STD. AA 7326102.(FOR PIPE OD 88.9mm TO 159mm STUB HEIGHT SHALL BE=65mm & FOR PIPE OD >219.1mm STUB HEIGHT SHALL BE=45mm)
3. STRAIGHT IMMERSION STUBS SHALL BE USED FOR PIPE OD'S 168.3mm & ABOVE. THE STUB HEIGHT FOR PIPE OD, 168.3mm TO <219.1mm SHALL BE 65mm.
4. SLANT IMMERSION STUBS SHALL BE USED FOR PIPE OD'S 88.9mm TO 159mm.
5. FOR MAIN PIPE OD'S 88.9mm & bELOW SUITABLE EXPANDER SHALL BE USED.

PRELIMINARY

REVIEWED										
			AC	PB	PB	AAM	PRELIMINARY		0	27.01.15
			APPROVED	REVIEWED	CHECKED	DRAWN	DESCRIPTION	RELEASE STATUS	REV.	DATE

INSTRUMENT INSTALLATION DIAGRAM

PANKI THERMAL POWER STATION
1 x 660 MW UNIT
KANPUR (UP)

UTTAR PRADESH RAJYA VIDYUT UTPADAN NIGAM LIMITED

DEVELOPMENT CONSULTANTS PVT. LTD
CONSULTING ENGINEERS

JOB NO. 14A14 | SCALE : NIL

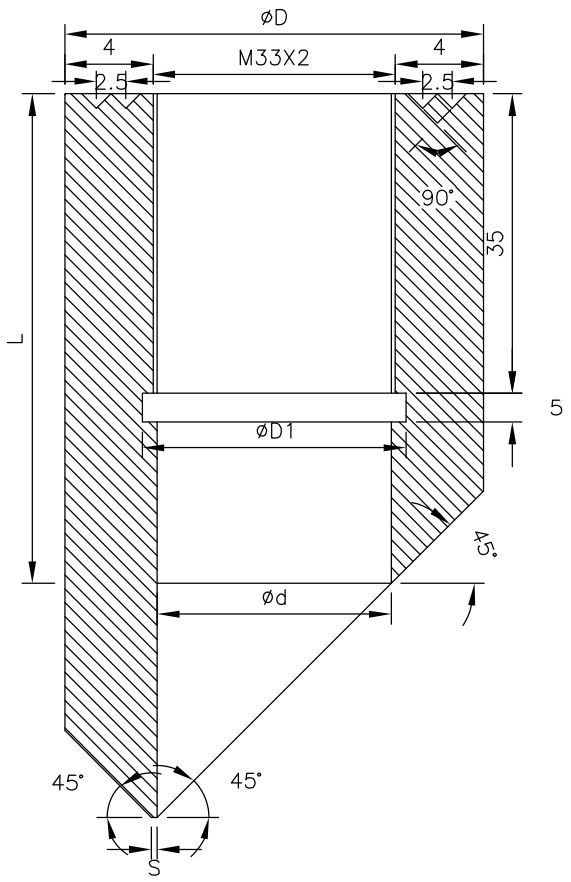
DWG. NO. 14A14-DWG-I-0010 | SHT. 14 OF 19 | REV. 0

FILE NAME D 14A14-DWG-I-0010-R0

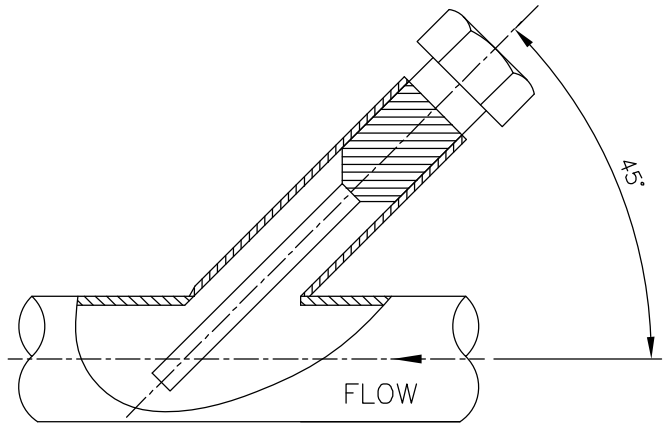
A3 (9-96) [420x297]

NOTE :-

1. MATERIAL OF THE BOSS SHALL BE THE SAME AS THE PIPE INTO WHICH IT IS WELDED.
2. LENGTH OF THE STUB (L) SHALL BE 65/45 mm DEPENDING UPON PIPE SIZE, AS PER CORPORATE STD. AA 7326102.(FOR PIPE OD 88.9mm TO 159mm STUB HEIGHT SHALL BE=65mm & FOR PIPE OD >219.1mm STUB HEIGHT SHALL BE=45mm)
3. STRAIGHT IMMERSION STUBS SHALL BE USED FOR PIPE OD'S 168.3mm & ABOVE. THE STUB HEIGHT FOR PIPE OD, 168.3mm TO <219.1mm SHALL BE 65mm.
4. SLANT IMMERSION STUBS SHALL BE USED FOR PIPE OD'S 88.9mm TO 159mm.
5. FOR MAIN PIPE OD'S 88.9mm & bELOW SUITABLE EXPANDER SHALL BE USED.

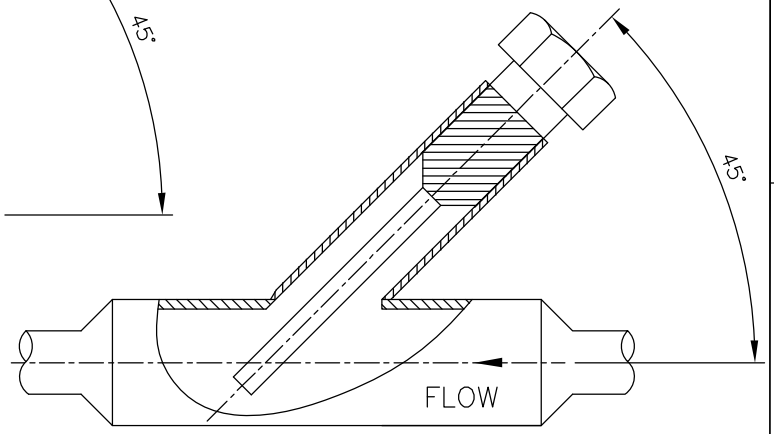


TEMPERATURE STUB
FOR SLANT IMMERSION



INSTALLATION TYPE-3

(FOR MAIN PIPE OD 88.9mm TO 159mm)



INSTALLATION TYPE-4

(FOR MAIN PIPE OD 88.9mm & BELOW)

FOR PIPE OD BELOW 219.1mm	29	55	33.5	1.5	65
FOR PIPE OD 219.1mm & ABOVE	29	55	33.5	1.5	45
MAIN PIPE SIZES	d	D	D1	S	L

PRELIMINARY

REVIEWED										
			AC	PB	PB	AAM	PRELIMINARY		0	27.01.15
			APPROVED	REVIEWED	CHECKED	DRAWN	DESCRIPTION	RELEASE STATUS	REV.	DATE

INSTRUMENT INSTALLATION DIAGRAM

PANKI THERMAL POWER STATION
1 x 660 MW UNIT
KANPUR (UP)

UTTAR PRADESH RAJYA VIDYUT UTPADAN NIGAM LIMITED

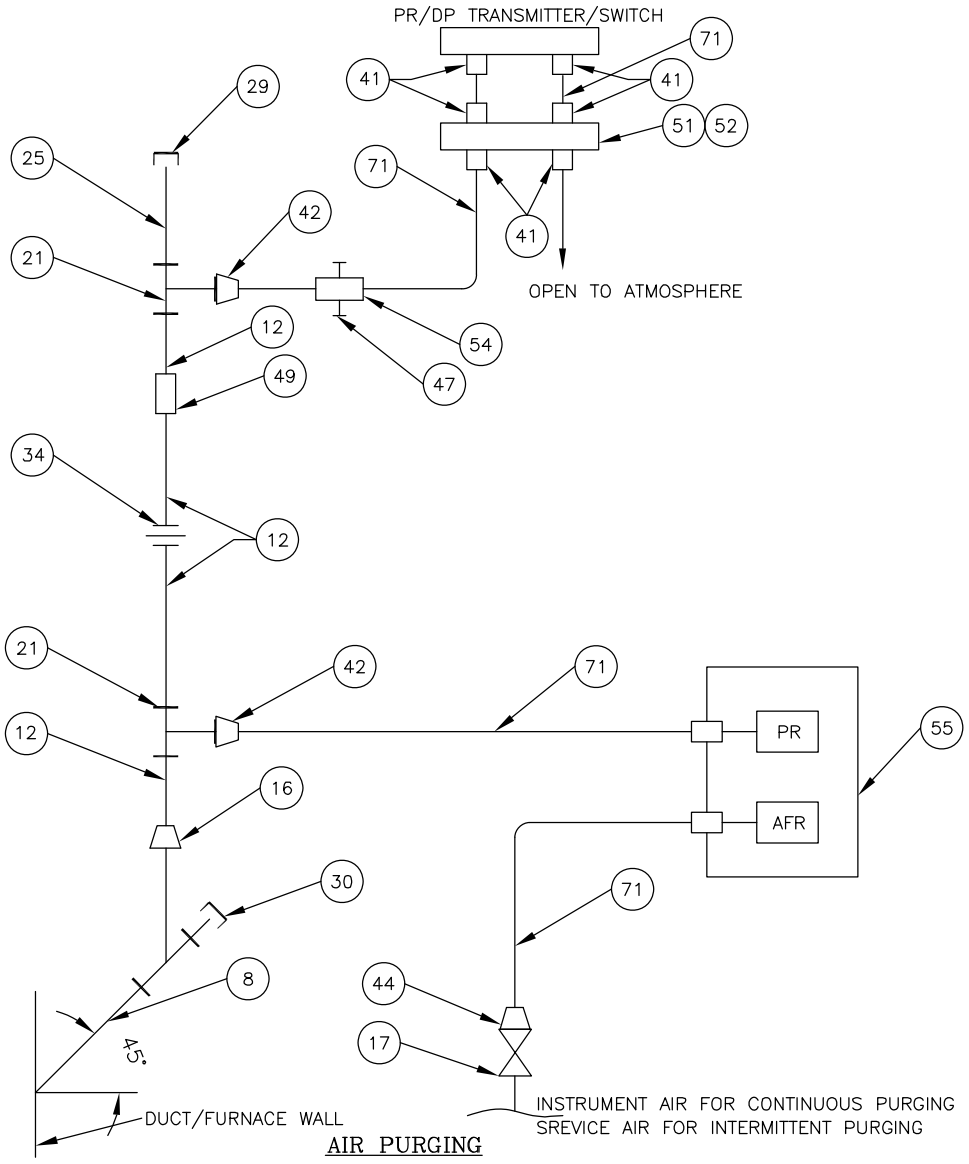
DEVELOPMENT CONSULTANTS PVT. LTD
CONSULTING ENGINEERS

JOB NO. 14A14 | SCALE : NIL

DWG. NO. 14A14-DWG-I-0010 | SHT. 15 OF 19 | REV. 0

FILE NAME 14A14-DWG-I-0010-R0

A3 (9-96) [420x297]



AIR PURGING

TAG NO.	DESCRIPTION	QTY.
	BILL OF MATERIAL	
71	1/2"OD IMPULSE TUBE,SS-316	
55	CONTINOUS PURGING ARRENGEMENT	1
54	3-WAY VALVE WITH 1/2" SWAGE LOCK CONNECTION	1
51or52	5-VALVE MANIFOLDS/3-VALVE MANIFOLDS/2-VALVE MANIFOLDS,SS-316	1
49	3/4"SW,CS/AS BULK HEAD PIPE UNION	1
47	QUICK DISCONNECT FITTING,CS	1
44	1/2"BW X 1/2"OD TUBE FITTING,SS-316	1
42	3/4"BW X 1/2"OD TUBE FITTING,SS-316	1
41	1/2"NPT(M) X 1/2"00 TUBE COMPRESSION FITTING,SS-316	6
34	3/4" SW,CS PIPE UNION	1
30	MS BLACK PIPE CAP	1
29	3/4"NPT(F) CS CAP	1
25	3/4"NPS,SCH-80 X 3/4"NPT(M)CS NIPPLE	2
21	3/4" EQUAL TEE,CS	2
17	1/2" SW GLOBLE VALVE, CS	1
16	MS BLACK PIPE TO 3/4" SW,CS REDUCER	1
12	3/4" NPS SCH-80 CARBON STEEL PIPE	AS REQD.
8	MS BLACK PIPE	AS REQD.

NOTE:-

FOR DP TRANSMITTER THE SECOND IMPULSE LINE SHALL BE CONNECTED SIMILAR TO FIRST IMPULSE LINE (TAG NO-12)

AFR- AIR FILTER REGULATOR

PR- PURGE ROTAMETER

PRELIMINARY

REVIEWED										
			AC	PB	PB	AAM	PRELIMINARY		0	27.01.15
			APPROVED	REVIEWED	CHECKED	DRAWN	DESCRIPTION	RELEASE STATUS	REV.	DATE

INSTRUMENT INSTALLATION DIAGRAM

PANKI THERMAL POWER STATION
1 x 660 MW UNIT
KANPUR (UP)

UTTAR PRADESH RAJYA VIDYUT UTPADAN NIGAM LIMITED

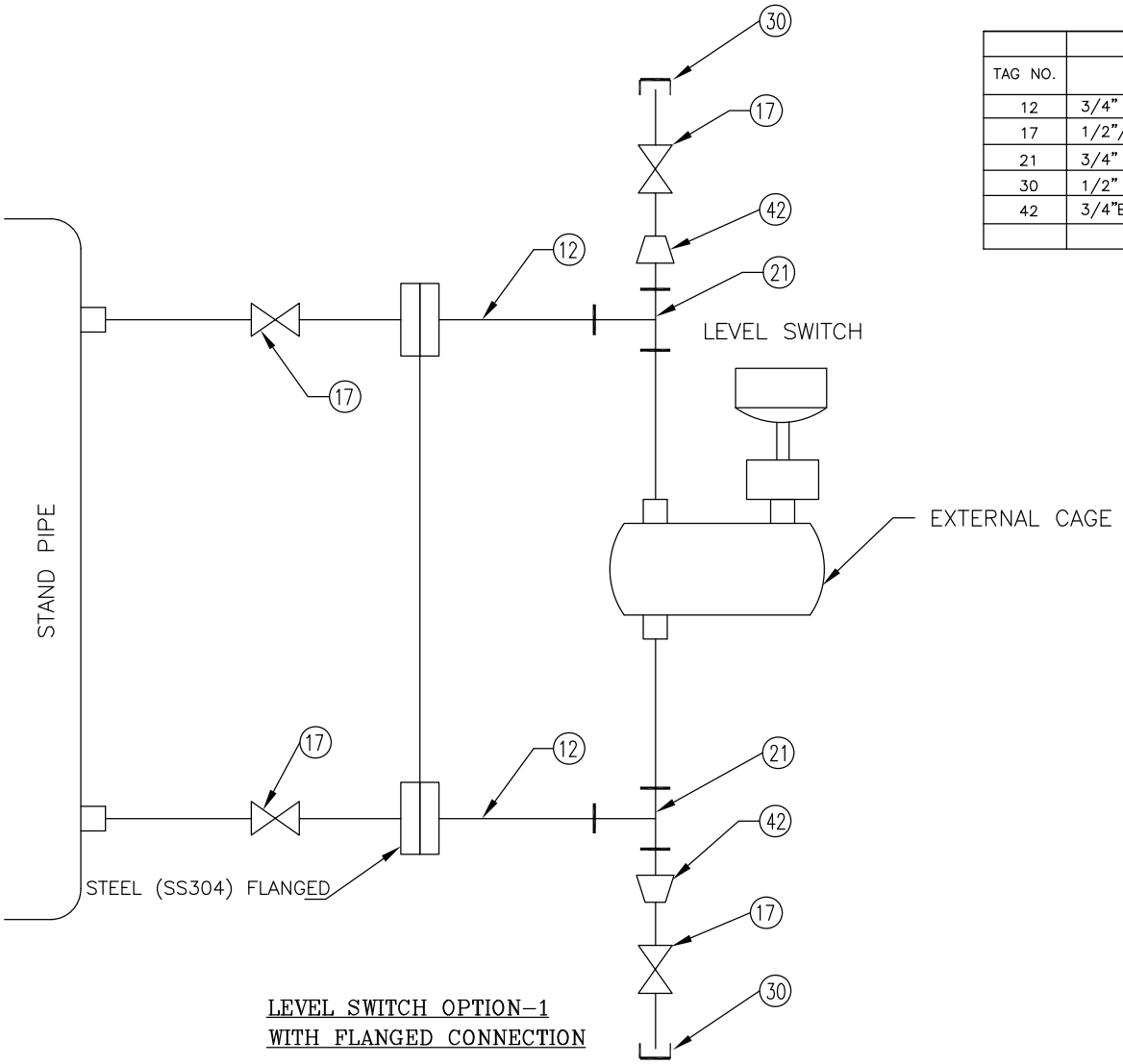
DEVELOPMENT CONSULTANTS PVT. LTD
CONSULTING ENGINEERS

JOB NO. 14A14 | SCALE : NIL

DWG. NO. 14A14-DWG-I-0010 | SHT. 16 OF 19 | REV. 0

FILE NAME D 14A14-DWG-I-0010-R0

A3 (9-96) [420x297]



LEVEL SWITCH OPTION–1
WITH FLANGED CONNECTION

	BILL OF MATERIAL	
TAG NO.	DESCRIPTION	QTY.
12	3/4" NPS SCH–80 CARBON STEEL PIPE	AS REQD.
17	1/2"/3/4"/1" SOCKET WELDED GLOBE VLV/ROOT VLV.	4
21	3/4" EQUAL TEE,CS	2
30	1/2" NPT (F) CS CAP	2
42	3/4"BW X 1/2"OD TUBE FITTING,SS–316	2

PRELIMINARY

REVIEWED										
			AC	PB	PB	AAM	PRELIMINARY		0	27.01.15
			APPROVED	REVIEWED	CHECKED	DRAWN	DESCRIPTION	RELEASE STATUS	REV.	DATE

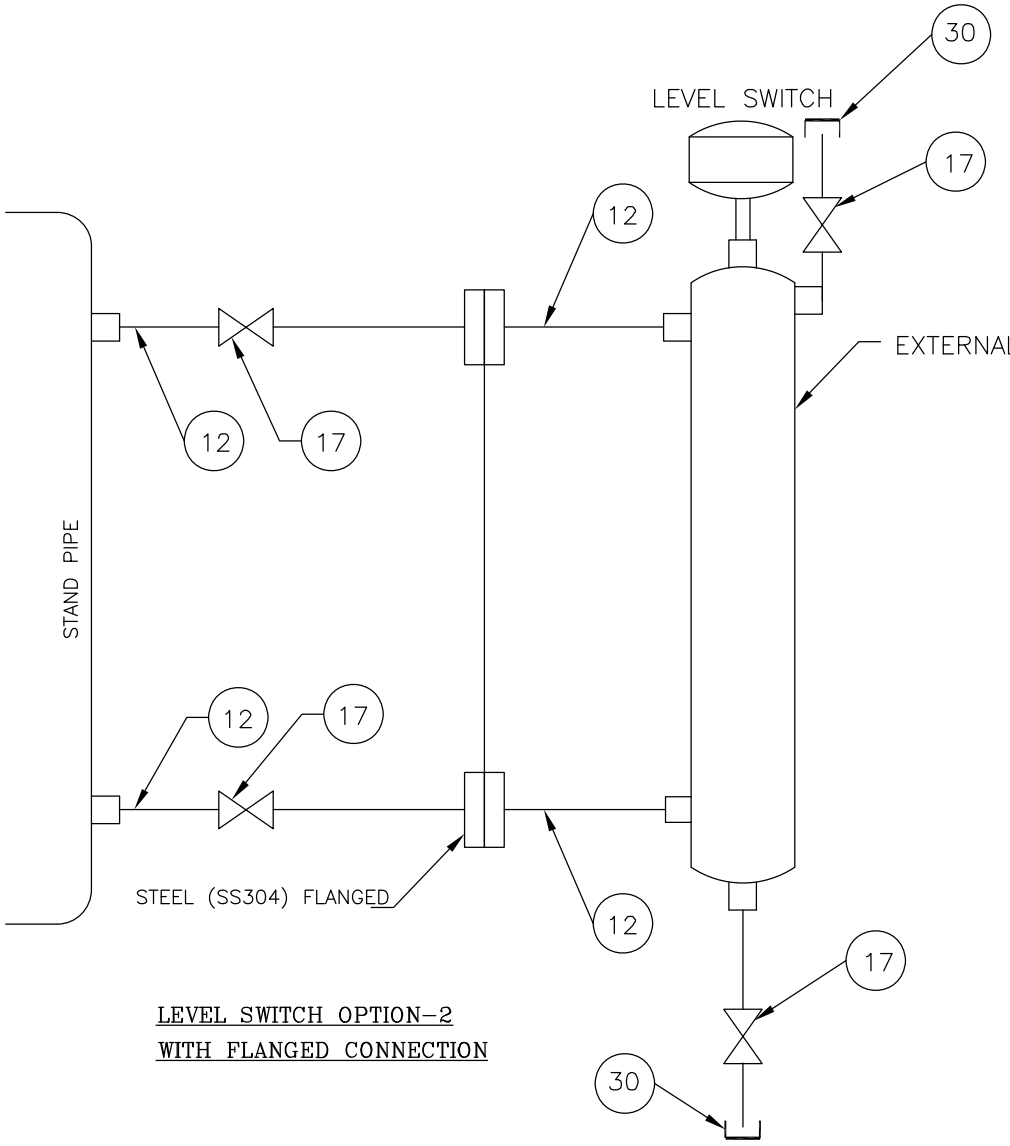
INSTRUMENT INSTALLATION DIAGRAM
PANKI THERMAL POWER STATION
1 x 660 MW UNIT
KANPUR (UP)
UTTAR PRADESH RAJYA VIDYUT UTPADAN NIGAM LIMITED

DEVELOPMENT CONSULTANTS PVT. LTD
CONSULTING ENGINEERS

JOB NO. 14A14 | SCALE : NIL
DWG. NO. 14A14–DWG–I–0010 | SHT. 17 OF 19 | REV. 0

FILE NAME 14A14–DWG–I–0010–R0

A3 (9–96) [420x297]



LEVEL SWITCH OPTION–2
WITH FLANGED CONNECTION

	BILL OF MATERIAL	
TAG NO.	DESCRIPTION	QTY.
12	3/4" NPS SCH–80 CARBON STEEL PIPE	AS REQD.
17	1/2"/3/4"/1" SOCKET WELDED GLOBE VLV/ROOT VLV.	4
21	3/4" EQUAL TEE,CS	2
30	1/2" NPT (F) CS CAP	2
42	3/4"BW X 1/2"OD TUBE FITTING,SS–316	2

PRELIMINARY

REVIEWED										
			AC	PB	PB	AAM	PRELIMINARY		0	27.01.15
			APPROVED	REVIEWED	CHECKED	DRAWN	DESCRIPTION	RELEASE STATUS	REV.	DATE

INSTRUMENT INSTALLATION DIAGRAM

PANKI THERMAL POWER STATION
1 x 660 MW UNIT
KANPUR (UP)

UTTAR PRADESH RAJYA VIDYUT UTPADAN NIGAM LIMITED

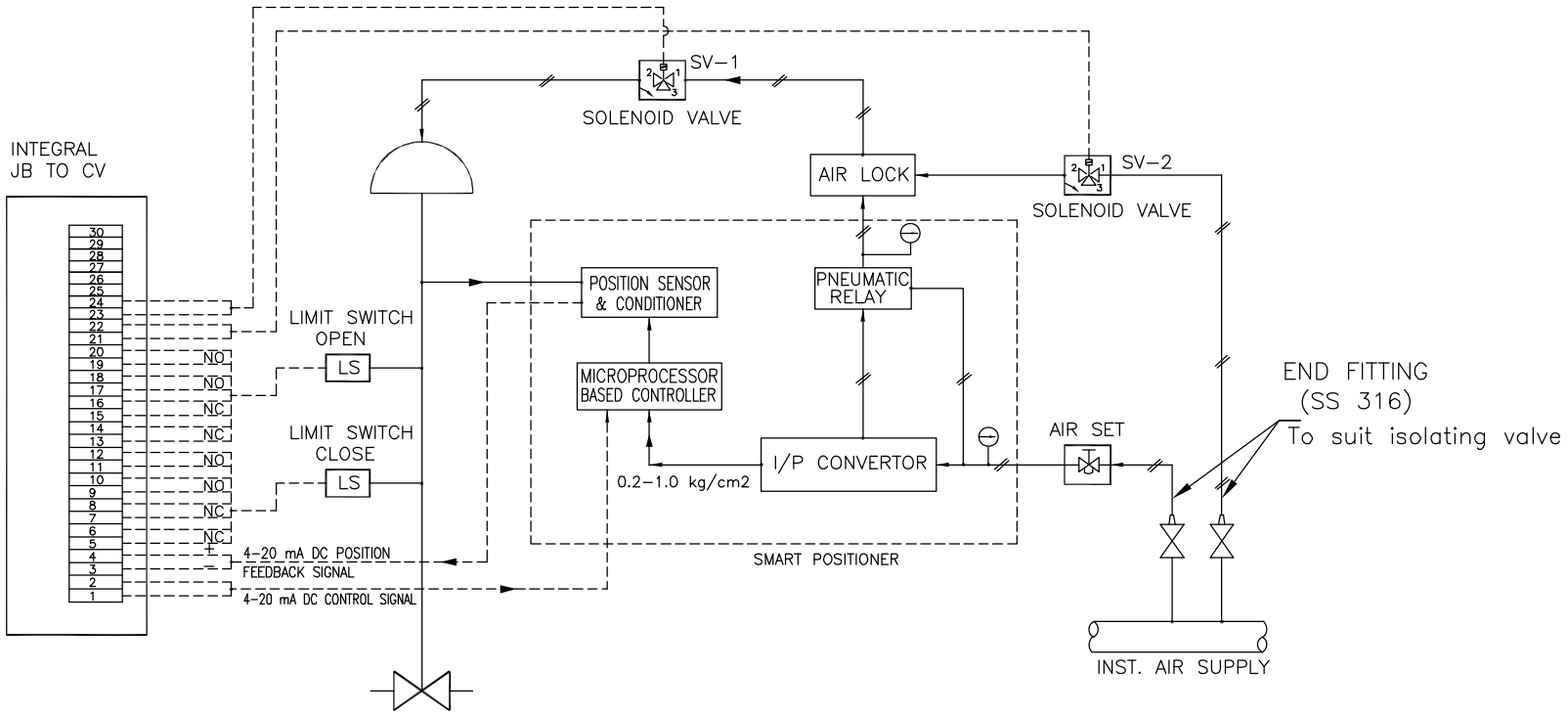
DEVELOPMENT CONSULTANTS PVT. LTD
CONSULTING ENGINEERS

JOB NO. 14A14 | SCALE : NIL

DWG. NO. 14A14–DWG–I–0010 | SHT. 18 OF 19 | REV. 0

FILE NAME 14A14–DWG–I–0010–R0

A3 (9–96) [420x297]



CONTROL VALVE

NOTE:–

1. SOLENOID VALVE (SV–1) WILL BE PROVIDED, IF REQUIED FOR ON/OFF DUTY VALVE OR FOR OVER–RIDING THE CONTROLLER SIGNAL. OR FOR INTERLOCK CONDITION.
2. SOLENOID VALVE (SV–2) IS PROVIDED FOR VALVE STAYPUT POSITION REQUIREMENT ON CONTROLLER SIGNAL FAILURE.
3. SOLENOID VALVES PORT CONDITION:
   PORT 1 AND 2 SHALL BE CONNECTED UNDER DE–ENERGISED CONDITION.
   PORT 2 AND 3 SHALL BE CONNECTED UNDER ENERGISED CONDITION.
4. FOR ON/OFF DUTY PNEUMATIC CONTROL VALVE THE FOLLOWING ACCESSORIES SHALL NOT BE APPLICABLE:–
   a) POSITIONER
   b) POSITIONER TRANSMITTER
   c) I/P CONVERTOR
   d) AIR LOCK
   e) SMART POSITIONER
5. TWELVE (12) METERS (MIN.) OF COPPER TUBING FROM INST. AIR HDR ISOLATING VALVE TO CONTROL VALVE IS TO BE SUPPLIED ALONGWITH CONTROL VALVE. THE TUBING SHALL BE SS316 FULLY ANEALEAD,SOFT, PVC COATED CONFORMING TO ASTM–B75
6. INST AIR HDR ISOLATING VALVE HAVING SCREWED CONNECTION AS PER IS–554 SHALL BE PROVIDED

CONTROL VALVE
(WITH PNEUMATIC ACTUATOR)

PRELIMINARY

REVIEWED										
			AC	PB	PB	AAM	PRELIMINARY		0	27.01.15
			APPROVED	REVIEWED	CHECKED	DRAWN	DESCRIPTION	RELEASE STATUS	REV.	DATE

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DWG. NO. 14A14–DWG–I–0010 | SHT. 19 OF 19 | REV. 0

FILE NAME 14A14–DWG–I–0010–R0

A3 (9–96) [420x297]

LOCAL CONTROL PANEL SPECIFICATION & QUALITY PLAN

xi. Bidder shall provide Ammeters on control ~~panel/desk~~ for all HT motor current and important LT ~~motor~~ ≥ 30 KW & other important drives and ~~voltmeter for~~ LT bus voltage.

14.24.00 RELAY BASED LOCAL CONTROL PANEL/DESK

Local control panel shall be of 2.5 mm steel construction, free standing type, totally enclosed dust and vermin proof with enclosure protection class of IP-65 as per IS: 13947 and colour shall be as per shade no. RAL 7032/7035. One uniform colour shade as finalized during detailed engineering shall be applicable for complete plant.
Panel shall be mounted on vibration dampers secured to steel frame on to the floor. Equipment and relays mounted on the panel shall be easily accessible. The panel shall be supplied completely wired upto terminal blocks for connecting external cables entering the panel from the bottom. Blank removable gland plate shall be provided with double compression type cable glands/conduits knockout along with the panel.

Terminal block shall be rated 650 volts grade, 10 Amps rated minimum made up of unbreakable polyamide 6.6 grade and shall have strap cage clamp type screw less terminals suitable for connection with 2x2.5 sq mm copper conductors on each side. Terminal block shall be provided with white marking strips. All metal parts shall be of non-ferrous material. The terminal blocks shall be arranged with at least 100 mm clearance between two sets of terminal blocks. The minimum clearance between the first row of terminal blocks and the associated cable gland plate shall be 250 mm. Fuses shall not be mounted on terminal blocks. At least 20 percent spare unused terminals fully wired shall be provided on terminal block.

Contactors, Relays, timers and other devices mounted on the panel shall have clearly visible identification marking. Separate contactors shall be provided for start & stop command. Common contactor for start & stop command are not acceptable. All fuses shall be HRC semiconductor type of AC supply. HRC link & fuse shall be of removable type having 45 kA rupturing capacity (min) for protection of various circuits.

The panel shall be provided with a 50x6 mm tinned copper earthing strip running throughout the length of the panel at the bottom. Panel shall be provided with space heaters with isolating DPN MCB, and thermostats. LED based lamps illuminating lights, complete with door switches; and 1 no. 6 pin 6/16 amps sockets with DPN MCB.

Panel shall be provided with fluorescent illuminating lamps with door switch and 6 point 6/16A, 230V AC socket with switch for maintenance purposes. Panel shall have removable lifting eye bolts for safe lifting from top during handling. Control power supply shall be provided from dual redundant feeders with auto change over scheme, surge protection devices and Power/Volt/AM meter.

The panel shall be provided with push buttons, indicating lamps, annunciators, indicating instruments, interlock/ deinterlock switches etc., required for the complete system. General details as specified in Vol. V, chapter 6 shall also be referred for engineering and design of relay panel/desk.

Coloured Mimic with 6/7 mm thickness sheet for respective plant lay out shall be provided as specified in Annexure A, control system philosophy.

20% spare relays of each type and rating shall be mounted and wired in relays control panel/Desk. All contacts of relays shall be terminated in terminal blocks of relay control panel/Desk, Additionally in the relay control panel/Desk, 20% spare wired terminal blocks shall be 'provided so that additional relays can be mounted and wired.

The annunciation system shall consist of panel mounted audio-visual windows of 50x75 mm provided with plug-in-type solid-state logic 16 nos. high intensity LEDs in parallel. EACH relay based control panel shall be provided with 30 nos min. facia windows. Initiating contacts may be either NO or NC; a jumper or switch shall be provided in each card to make it suitable for either type of contact. A set of acknowledge, reset and test push buttons shall be provided on the panel. All printed circuit boards shall be of epoxy fiber glass construction.

The sequence of annunciation shall be as follows:

	Condition	**Visual**	**Audible**
	Normal	OFF	OFF
	Alarm	Flashing	ON
	Acknowledge	Steady	OFF
	Return to Normal:		
a.	Before acknowledge	Flashing	ON
b.	After acknowledge	Steady	OFF
	Reset:		
a.	Alarm condition	No change	No change
b.	Return to normal	OFF	OFF

14.25.00 **LOCAL CONTROL PANEL (Protection class as per cl. No. 1.07.00, vol V, Part B, Ch-1)**

Local control panels provided anywhere in the plant shall be totally enclosed, Dust tight and Vermin proof having IP-65 protection. It shall be fabricated of 3 mm CRCA sheet. Panel should be floor mounted, compartmentalized, hinged door for access to compartment. It shall have switches, push buttons, LED clustered type indicating lights, indicating instruments and HW annunciation etc. and sufficient number of panel space heater along with thermostat and 5/15A receptacles. In General Local control panel shall comply the features as specified in Vol. V, chapter 6.

6.10.00 CONSTRUCTIONAL FEATURES OF LOCAL CONTROL PANELS, CONSOLES, CONTROL Desk, CUBICLES & ENCLOSURES

i. All control panels, cubicles, consoles, SOV panels and enclosures provided anywhere for subject plant per this specification shall be of free standing type and shall be constructed of specified gauge of steel plates (CRCA). The minimum sheet thickness of panels shall be as follows unless otherwise specified herein.

Side and top – not less than 1.6 mm
Door – not less than 2.0 mm
Mounting plate – 2.5 mm
Base metal plate - 2.5 mm
Gland plate – 3 mm

ii. The panels, consoles/desks shall be reinforced as required to ensure true surfaces and adequate support for instruments mounted thereon. All instrument cutouts, mounting studs, and support brackets shall be accurately located. All welds on the exposed panel surfaces shall be ground smooth. Finished panel surfaces shall be free from waves, bellies, or other imperfections. Unless specified, otherwise, panel doors shall be 4 points hinged and shall have turned back edges and additional bracing where required to ensure rigidity. Door hinges shall be of the concealed type. Door latches shall be of the three/four -point type to ensure tight closing. Door locks shall be furnished which will allow actuation of all locks by a single master key. All panels shall have removable lifting eyebolts for safe lifting from top during storage and installation handling.

Cabinet doors shall be hinged and shall have turned back edges and additional braking where required ensuring rigidity. Hinges shall be of concealed type. Door latches shall be of three/four -point type to assure tight closing. Detachable lifting eyes or angles shall be furnished at the top of each separately shipped section and all necessary provisions shall be made to facilitate handling without damage. Front and rear doors shall be provided with locking arrangements with a master key for all cabinets. If width of a cabinet is equal or more than 800 mm, double doors shall be provided.

iii. All panels shall be mounted on vibration dampers, which are secured to C-channels mounted on the floor. The channels shall be field welded to steel plates set into the concrete flooring. The steel plates shall be located such as to approximate the outline of panel bases. The exact mounting details shall be as approved by the owner during detailed engineering stage. All panels shall be provided with adequate ventilation and packaging density of components shall be restricted so as to limit the temperature rise above ambient to 10°C under the worst conditions. All panels shall have auto on/off switch for internal lighting. All the power supply circuit for control panels shall be provided with auto changeover circuitry.

iv. In each panel /cabinet, a 24 VDC Voltmeter digital type shall be provided to check the Field Interrogation voltage.

v. Exhaust Fans with louvers & filters shall be provided on upper side to remove hot air in all consoles and panels.

vi. Fire & Smoke detectors shall be provided inside the Control room mounted system/control cabinets.

vii. Feeder failure/ healthy indication shall be provided in each cabinet & remote indication shall be hooked up to DDCMIS/ PLC/annunciation & suitably grouped.

viii. All the panels shall be equipped with Anti vibration pad of min. 15 mm size thickness. Cable gland plate thickness shall be 3 mm. C Channel height shall be min. 100 mm.

ix. Doors shall be provided with neoprene/polyurethane gasket only. The front and rear doors shall be of full height .

x. Protection class shall be as specified at Vol. V, Part B, chapter 1.

xi. All the cable entries shall be at the bottom of electronic cubicles/control panels.

xii. Control panels shall be provided with proper arrangement and hardware to terminate the inert gas required for fire protection.

xiii. 25x6 mm copper ground bus to be provided for each panel/control desk.

xiv. Terminal blocks shall be Rail mounted 650 V AC grade Terminal blocks (Screw less cage clamp type) with markers and 20% spare wired terminals of each type.

xv. For Panels/cubicles internal wiring details, Bidder to refer Vol. V, Part B, Chapter 9.

6.11.00 TERMINATION/Marshalling CABINETS & Interposing Relay Panel

Marshalling/Termination cabinets for the control system shall be supplied for terminating all cables originating from the field, MCC/SWGR or any other source

of signal and for distributing the signals to different functional panels, MCC/SWGR and control cubicles.

Incoming cables from the field, MCC/SWGR or any other source of signal shall be terminated in suitable terminal blocks in logical sequence.

Prefabricated cables with plug in connectors at both ends shall be used for extending the signals to the functional panels. Matching plug sockets shall be provided in the termination cabinets for terminating the plugs.

Interposing relay panels for the system shall be supplied for mounting interposing relays & terminating all cables originating from the DO cards in case of solenoid valves, HW Annunciation windows and other required services etc. IPR panels shall be placed in CER and LCR.

Interposing relay shall be mounted in respective SWGR/MCC/integral starter required for commands signals of HT/LT unidirectional drives and bidirectional drives, breakers, isolators, bus couplers etc from DDCMIS/DCS/PLC or any control system.

Terminal blocks shall be located inside the cabinets on support wings fabricated of metal plates.

The plug socket shall be mounted on hinged plates to provide an access to the rear pins of the plugs.

General features of termination cabinets and accessories shall conform to the general design and construction specification of panels. Terminal blocks shall be Rail mounted 650 V AC grade Terminal blocks (Screw less cage clamp type) with markers and 20% spare wired terminals.

Wiring shall be 650V grade. PVC insulated FRLS stranded copper wire.

6.12.00 SURFACE PREPARATION AND PAINTING

All panel exterior steel surfaces shall be ground smooth, and painted as specified below:

Suitable filler shall be applied to all pits, blemishes and voids in the surfaces. The filler shall be sand blasted so that surfaces are level and flat, corners are smooth and even. Exposed raw metal edges shall be ground burr free. The entire panel surface shall be sand blasted to remove rust and scale and all other residue due to the fabrication operation. Oil grease and salts etc. shall be removed from the panels by one or more solvent cleaning methods. Alternatively 7 tank process shall be followed.

Two spray coats of inhibitive epoxy primer – surface shall be applied to all exterior and interior surfaces, each coat of primer surface shall be of dry film thickness of 1.5 mil. A minimum of two spray coats of final finish colour (Catalysed epoxy finish) shall be applied to all surfaces of dry film thickness 2.0 mil. The final finished thickness of paint film on steel shall not be less than 65-75 micron for sheet thickness of 2 mm and 50 microns for sheet thickness of 1.6

mm. As an alternative, single coat of anodic dip coat primer along with single textured powder coating with epoxy polyester meeting the thickness requirement is also acceptable.
The Bidder shall furnish sufficient touch-up paint for one complete finish coat on all exterior factory applied painted surface of each item of equipment.

The finish colours for exterior and interior surfaces shall conform to the following shades:

a) Exterior - RAL 7032/RAL 7035.

b) Interior - Glossy white two coats/RAL 7035 with fire resistant paint

One uniform colour shade as finalized by owner during detailed engineering shall be applicable for complete plant.

Paint films, which show sags, checks, blisters teardrops, fat edges or other painting imperfections, shall not be acceptable and if any such defects appear, they shall be repaired by and at the expenses of the Bidder.

6.13.00 PANEL ILLUMINATION

Panels shall be provided with LED based illuminating lamps with door switch and six (6) point 5/15A, 240V AC universal type power sockets with switch for maintenance purposes. These switches shall be with quick make and break mechanism. 100 % spare LED lamps shall be provided with each panel, these are in additional to mandatory spares.

6.14.00 Panel Cooling Fans (for ventilation of the DDCMIS/ PLC / DCS & other cabinets)

Filter Fan for electrical cabinets and enclosures to be used with 120 V or 230 V AC versions having very low acoustic noise and lower power consumption. The fans must have UL approval and should have air flow volume as per the cabinet requirement. Wherever required, the EMC filter fans may be used. Fans should have a life of 50,000 Hours at 40 Deg C. Fan Housing, cover should be of V0 material as per UL94. Filter mat should be compliant to EU3 according to DIN 24185 standard and have a filtering degree of 80 to 90 %. The Ambient temperature range °C should be -10 to +70 Deg C and Protection class should be IP 54. Filter Material shall be Synthetic fibre with progressive construction, temperature resistant to +100°C, self extinguishing, Class F1 as per DIN 53438 standard.

6.15.00 Panel Thermostat (for temperature control of the DDCMIS/PLC/DCS panel – to be connected to switch On/Off Fan/Heater)

The panel thermostat shall be DIN Rail Mounted with an inbuilt snap action thermostatic bimetal sensor and shall be connected in series with the load without any additional supply voltage. The panel thermostat shall be available in setting temperature range of -20 deg C to 40 deg C or 0 to 60 deg C with separate modules for NO or NC contact. The electrical life at rated load AC1 shall be 1 Lakh switching cycles and shall work at an ambient temperature of -45 to +80 deg C. With AgNi contact material for switching, the contact current carrying

capacity shall be 10 Amp at a rated voltage of 250 V AC with a dielectric strength between open contacts of 500 V AC and shall have UL approval.

6.16.00 FUSES & MCB

All fuses shall be fast acting semiconductor types for AC supply and compatible to the UPS fuses. For all DC Powered devices, similarly the fuses shall be fast acting compatible to DCDB fuse provisions. All the AC power supplies shall be provided with the protection of Fast acting semi conductor fuses & 2 P thermo magnetic type MCB. For all the DC power supply circuits, electronic type DC MCB shall be used only. Make of DC MCB shall be Siemens, Phoenix contacts, Murr, Weidmuller, or Lutze.

50 % spare fuses shall be provided with each panel, these are in additional to mandatory spares.

6.17.00 NAME PLATES AND LABELS

Name plates of adequate size shall be provided for each panel on front and rear of the panel. Instruments/other accessories mounted inside the panels shall have identification marking clearly visible from inside.

Devices to be mounted on the panels shall also be labeled on the panels shall also be labeled on the outside of the panel. Name plates shall be of polyamide sheets with black letters on white background. Name plates shall be attached to the boards by means of stainless steel panhead screws. Fuses provided for protection of various boxes shall be accessible for replacement. Fuse boxes shall be provided with circuit label and fuse rated current and voltage.

Markings/Labels

All markers/labels shall be made of halogen & silicon free polyamide material with inflammability class V2 as per UL 94, ensuring scratch proof printing with the use of environment friendly solvent free ink & latest BLUEMARK UV technology so as to comply the WIPE RESISITANCE according to DIN EN 61010-1/VDE 0411-1.

6.18.00 QUANTITIES

Refer Appendix-I to Part-A, Vol.-V of Technical Specifications. Quantities indicated are the minimum requirements, however each & every item shall be provided as per system requirements.

6.19.00 Design Criteria for Control Rooms:

The interiors of the each control Room shall be aesthetically designed with modern designs and technologies. The bidder shall have 2-D and 3-D software for designing the control room layouts. The bidder shall have thorough knowledge on Indian power plant control room requirements. Control rooms shall also be designed as per standard “ISO 11064 (1-7) - Ergonomic design of control centres”.

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STANDARD QUALITY PLAN
FOR
LOCAL CONTROL PANEL

STD QUALITY PLAN NO.:	**PE-QP-999-145-I056**
VOLUME	IIB
SECTION	D
REV. NO.	01 DATE: 22-02-2008
SHEET	1 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $ P	Agency $ W	Agency $ V	Remarks
	INCOMING											
1.0	Sheet Steel (CRCA & HR)	1. Chemical Composition	MA	Chemical analysis	Sample	Relevant standard	Relevant standard	Test Certificate	3	---	2	
		2. Bend Test	CR	Mech. test	Sample	Relevant standard	Relevant standard	Log Book	2	---	---	
		3. Surface finish	MA	Visual	100%	Factory Standard / Sample	Factory Standard / Sample	Log Book	2	---	---	
		4. Waviness	MA	Visual	100%	Factory Standard	No Waviness	Log Book	2	---	---	
		5. Thickness	MA	Measurement	100%	BHEL Spec.	BHEL Spec.	Log Book	2	---	---	
		6. Mill marking	MA	Visual	100%	Factory Standard	Factory Standard	Log Book	2	---	1	
2.0	Flats / Angles / Channels	1. Dimensions	MA	Measurement	Sample	Relevant standard	Relevant standard	Log Book	2	---	---	
		2. Surface Defects	MA	Visual	100%	Factory Standard / Sample	Factory Standard / Sample	Log Book	2	---	---	
		3. Straightness	MA	Measurement	100%	Factory Std.	Factory Std.	Log Book	2	---	---	
		4. Mill marking	MA	Visual	100%	Relevant standard	Relevant standard	Log Book	2	---	1	
3.0	Cables / Wires	1. Visual / Surface defects	MA	Visual	100%	BHEL Spec. and Relevant standard	BHEL Spec. and Relevant standard	Log Book	2	---	---	
		2. IR and HV	MA	Electrical	100%	BHEL Spec. and Relevant standard	BHEL Spec. and Relevant standard	Log Book	2	---	---	

LEGEND: * CR - Critical characteristics; MA - Major characteristics; MI - Minor characteristics

$ P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.

1 - BHEL; 2 - Vendor; 3 - Sub-vendor

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STANDARD QUALITY PLAN
FOR
LOCAL CONTROL PANEL

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Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
		3. Conductor a) Resistance b) Size c) Sheet colour	 MA MA MA	 Electrical Measurement Visual	 100% 100% 100%	BHEL Spec. and Relevant standard	BHEL Spec. and Relevant standard	Log Book	2	---	---	
		4. Type / Routine Test Certificates	MA	Verification	100%	BHEL Spec. and Relevant standard	BHEL Spec. and Relevant standard	Log Book	3	---	2	
4.0	Electrical Components like Annunciator Transformers Lamps Switches PBs Contactors Relays Timers Space Heaters Thermostat Indicating meters etc.	1. Verification at make and Type	CR	Visual	Sample	BHEL Spec. and BOM	BHEL Spec. and BOM	Log Book	2	---	---	
		2. Verification of Test Certificates	CR	Scrutiny of Type / Routine T.Cs.	100%	Relevant standard	Relevant standard	Log Book	2	---	---	
		3. Operation / Functional check	CR	Electrical	Sample+ 100%@	Relevant standard & Catalogue	Relevant standard & Catalogue	Log Book	2	---	---	+ for relay & contactors only
		4. I.R.	MA	Electrical	100%	Relevant standard & Catalogue	Relevant standard & Catalogue	Log Book	2	---	---	@ for all components except relays & contactors.
		5. H.V.	MA	Electrical	100%	Relevant standard & Catalogue	Relevant standard & Catalogue	Log Book	2	---	---	
		6. Calibration	MA	Electrical	100%	Relevant standard & Catalogue	Relevant standard & Catalogue	Log Book	2	---	1	
		7. Pick up / Drop off Voltage	MA	Electrical	100%	Relevant standard & Catalogue	Relevant standard & Catalogue	Log Book	2	---	---	

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STANDARD QUALITY PLAN
FOR
LOCAL CONTROL PANEL

STD QUALITY PLAN NO.: **PE-QP-999-145-I056**
VOLUME IIB
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REV. NO. 01 DATE: 22-02-2008
SHEET 3 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
5.0	Misc. Components like Gaskets, Terminal Blocks etc.	1. Verification of Type / Make	MA	Visual	Sample	BHEL Spec. & Mfrs. Catalogue	BHEL Spec. & Mfrs. Catalogue	Log Book	2	---	---	
		2. Surface defects	MA	Visual	Sample	BHEL Spec. & Mfrs. Catalogue	BHEL Spec. & Mfrs. Catalogue	Log Book	2	---	---	
		3. IR / HV on Terminal Blocks	MA	Electrical	Sample	BHEL Spec. & Mfrs. Catalogue	BHEL Spec. & Mfrs. Catalogue	Log Book	2	---	---	
	IN PROCESS											
6.0	Blanking / Bending / Forming	1. Dimensions	MI	Measurement	100%	Approved Mfr. drgs.	Approved Mfr. drgs.	Log Book	2	---	---	
		2. Surface defects after bending	MA	Visual	100%	Factory Standard	Factory Standard	Log Book	2	---	---	
7.0	Nibbling / Punching	1. Cutout Sizes	MI	Measurement	100%	Approved Mfr. drgs.	Approved Mfr. drgs.	Log Book	2	---	---	
		2. Deburring	MA	Visual	100%	Approved Mfr. drgs.	Approved Mfr. drgs.	Log Book	2	---	---	
	ASSEMBLY											
8.0	Frame Assembly & Sheet fixing	1. Dimensions	MA	Measurement	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2	
		2. Alignment	MA	Measurement	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2	
		3. Welding Quality	MA	Visual	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2	
		4. Surface defects	MA	Visual	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2	

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STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

STD QUALITY PLAN NO.: **PE-QP-999-145-I056**
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Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
9.0	Pre-treatment and Painting	1. Pretreatment Process	MA	Visual	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	
		2. Process parameters like bath temp. concentration etc.	MA	Measurement	Periodic	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	
		3. Dipping / Removal Time	MA	Measurement	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	
		4. Surface quality after every dip	MA	Visual	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	
		5. Primer after phosphating	MA	Visual, Thickness	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	
		6. Putty Application & Rubbing after primer	MA	Visual	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	
		7. Paint first coat	MA	Visual, Thickness	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	
		8. Putty Application and Rubbing after first coat of paint	MA	Visual	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	
		9. Paint second coat	MA	Visual, Thickness, Scratch test Colour adhesion	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	

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STANDARD QUALITY PLAN
FOR
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REV. NO.	01 DATE: 22-02-2008
SHEET	5 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $ P	Agency $ W	Agency $ V	Remarks
10.	Panel Wiring	1. Wiring Layout	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	---	
		2. Wiring Termination (Crimped Lugs)	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	---	
		3. Ferrule numbers	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	---	
		4. Colour of wiring	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	1	
		5. Size of Conductor	MA	Measurement	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	1	
11.	Component Mounting	1. Correct components	MA	Visual	100%	Approved drgs., Specs. & BOM	Approved drgs., Specs. & BOM	Log Book	2	---	---	
		2. Fixing	MA	Visual	100%	Approved drgs., Specs. & BOM	Approved drgs., Specs. & BOM	Log Book	2	---	---	
	FINAL											
12.	Final Inspection	1. Workmanship	MA	Visual	100%	Factory Standard	Factory Standard	Inspection Report	2	1	1	At Random by BHEL, based on 100 % internal test reports by Mfr.
		2. Component layout (neatness, accessibility & safety) Mounting / Proper fixing of all components	MA	Visual	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	
		3. Components identification Marking / Name plates	MA	Visual	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	

LEGEND: * CR - Critical characteristics; MA - Major characteristics; MI - Minor characteristics

$ P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.

1 - BHEL; 2 - Vendor; 3 - Sub-vendor

PEM :: C&I

STANDARD QUALITY PLAN
FOR
LOCAL CONTROL PANEL

STD QUALITY PLAN NO.:	**PE-QP-999-145-I056**
VOLUME	IIB
SECTION	D
REV. NO.	01 DATE: 22-02-2008
SHEET	6 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $ P	Agency $ W	Agency $ V	Remarks
		5. Dimensions	MA	Measurement	100%	BHEL approved drg. / Spec., BOM	BHEL approved drg. / Spec., BOM	Inspection Report	2	1	1	
		6. Door functioning	MA	Functional	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	
		7. Paint Shade	CR	Visual	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	
		8. Paint Thickness	CR	Measurement	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	
		9. Workmanship of Gaskets	MA	Visual	100%	Factory Standard	Factory Standard	Inspection Report	2	1	1	
		10. Wiring Layout	MA	Visual	100%	BHEL approved drg.	BHEL approved drg.	Inspection Report	2	1	1	
		11. Wire Termination	MA	Pulling manually	Sample	-----	Firm termination	Inspection Report	2	1	1	
		12. Continuity	MA	Electrical	100%	-----	Continuity OK	Inspection Report	2	1	1	

At Random by BHEL, based on 100 % internal test reports by Mfr.

LEGEND: * CR - Critical characteristics; MA - Major characteristics; MI - Minor characteristics

$ P - Agency Performing the Test.; W - Agency Witnessing the Test.; V - Agency Verifying the Test.

1 - BHEL; 2 - Vendor; 3 - Sub-vendor

PEM :: C&I

STANDARD QUALITY PLAN
FOR
LOCAL CONTROL PANEL

STD QUALITY PLAN NO.:	**PE-QP-999-145-I056**
VOLUME	IIB
SECTION	D
REV. NO.	01 DATE: 22-02-2008
SHEET	7 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
13.	TYPE TEST	Degree of Protection	CR	Mech. Protection	Sample	BHEL approved spec., drg relevant IEC-60947, IEC-60079	BHEL approved spec., drg relevant IEC-60947, IEC-60079	Type Test Certificate	3	---	1	
14	ROUTINE TEST	IR before & after HV Test	CR	Electrical	100%	BHEL approved spec., drg., BOM & relevant standard	BHEL approved spec., drg., BOM & relevant standard	Test Report	2	1	1	
15	FUCTIONAL TEST	1. Control Logic Operation	CR	Electrical	100%	BHEL approved spec. / drg.	BHEL approved spec. / drg.	Inspection Report	2	1	1	
		2. Instrument Calibratio	CR	Electrical	10%	BHEL approved spec. / drg.	BHEL approved spec. / drg.	Inspection Report	2	1	1	
		3. Temperature rise	CR	Electrical	100%	BHEL approved spec/drg. & relevant standard	BHEL approved spec/drg & relevant standard	Inspection Report	2	1	1	

LEGEND: * CR - Critical characteristics; MA - Major characteristics; MI - Minor characteristics

$ P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.

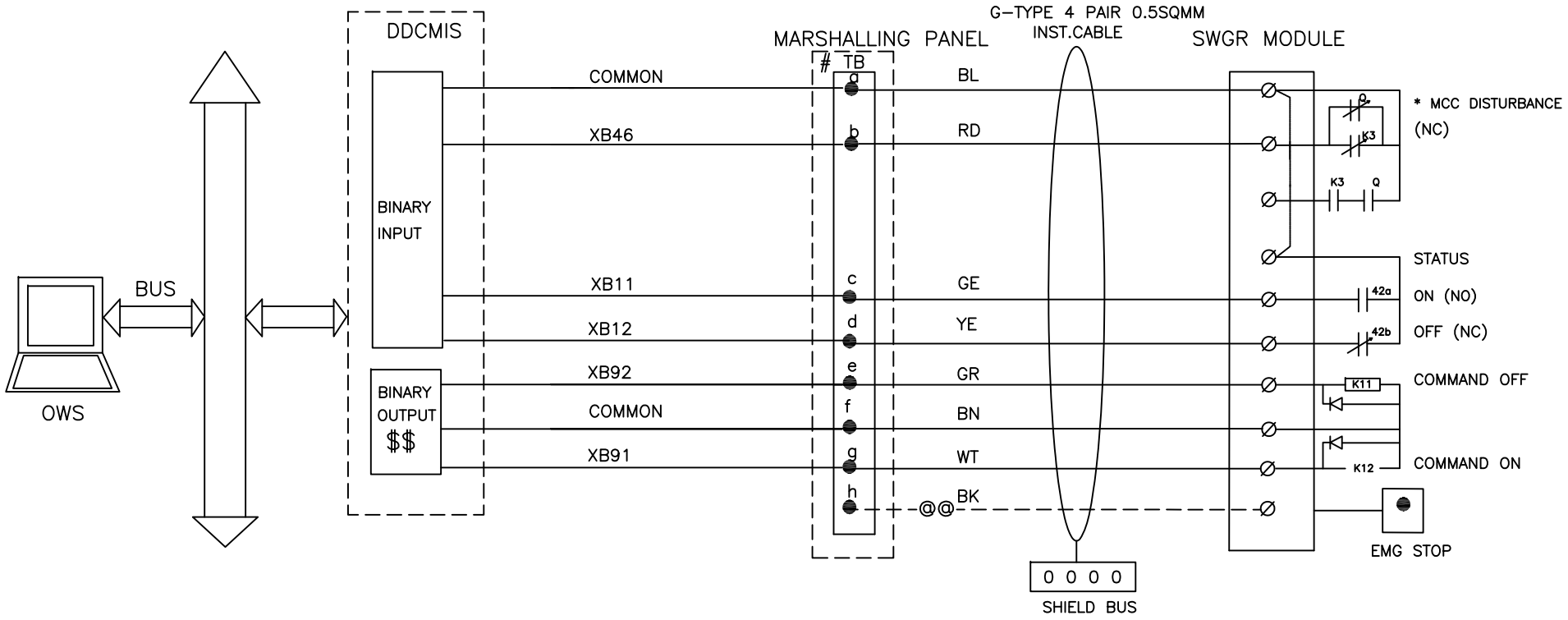
1 - BHEL; 2 - Vendor; 3 - Sub-vendor

APPLICABLE CABLE TYPES

Cable Sizes for 1X660MW TPS PANKI EXTN.	
Sl no.	Cable Type
G-TYPE	
1	2P X 0.5 sqmm
2	4P X 0.5 sq mm
3	8P X 0.5 sqmm
4	12P X 0.5 sqmm
F-TYPE	
1	4P X 0.5 sqmm
2	8P X 0.5 sqmm
3	12P X 0.5 sqmm
4	20P X 0.5 sqmm
CONTROL CABLE	
1	3C X 2.5 sqmm

DRIVE CONTROL PHILOSOPHY

DDCMIS INTERFACE WITH LT MCC (LT)

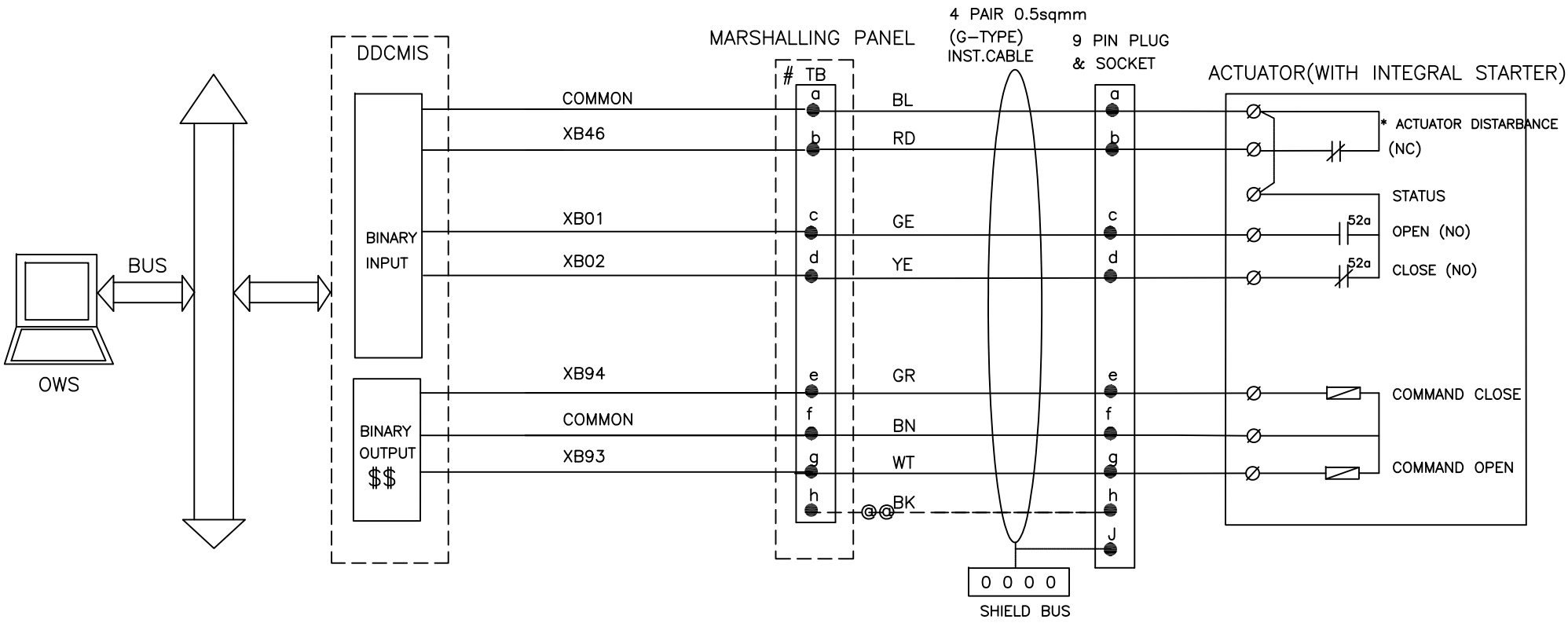


NOTE:-1 $$ REDUNDANT OUTPUTS WHEREVER APPLICABLE
NOTE:-2 # 8 LEVEL TERMINAL BLOCK
NOTE:-3 @@ INEACH DDCMIS POST,UNUSED TB'S ARE USED FOR SPARE CORE TERMINATION SEQUENTIALLY.
NOTE:-4 * MCC DISTURBED= THERMAL O/L OPT/CONT SUPP FAIL/EPB OPTD /DRIVE POWER SUPPLY OFF

This pg is part of spec PE-TS-426-673A-A001

BHEL 313/500	UP RAJYA VIDYUT UTPADAN NIGAM LTD 1 X 660 MW PANKI TPS	DRG.NO.	9962-001-PE-405-PVI-B-152
	DDCMIS INTERFACE WITH LT MCC (LT)	SHT	05 OF 34

DDCMIS INTERFACE WITH BID/MOV/MOD

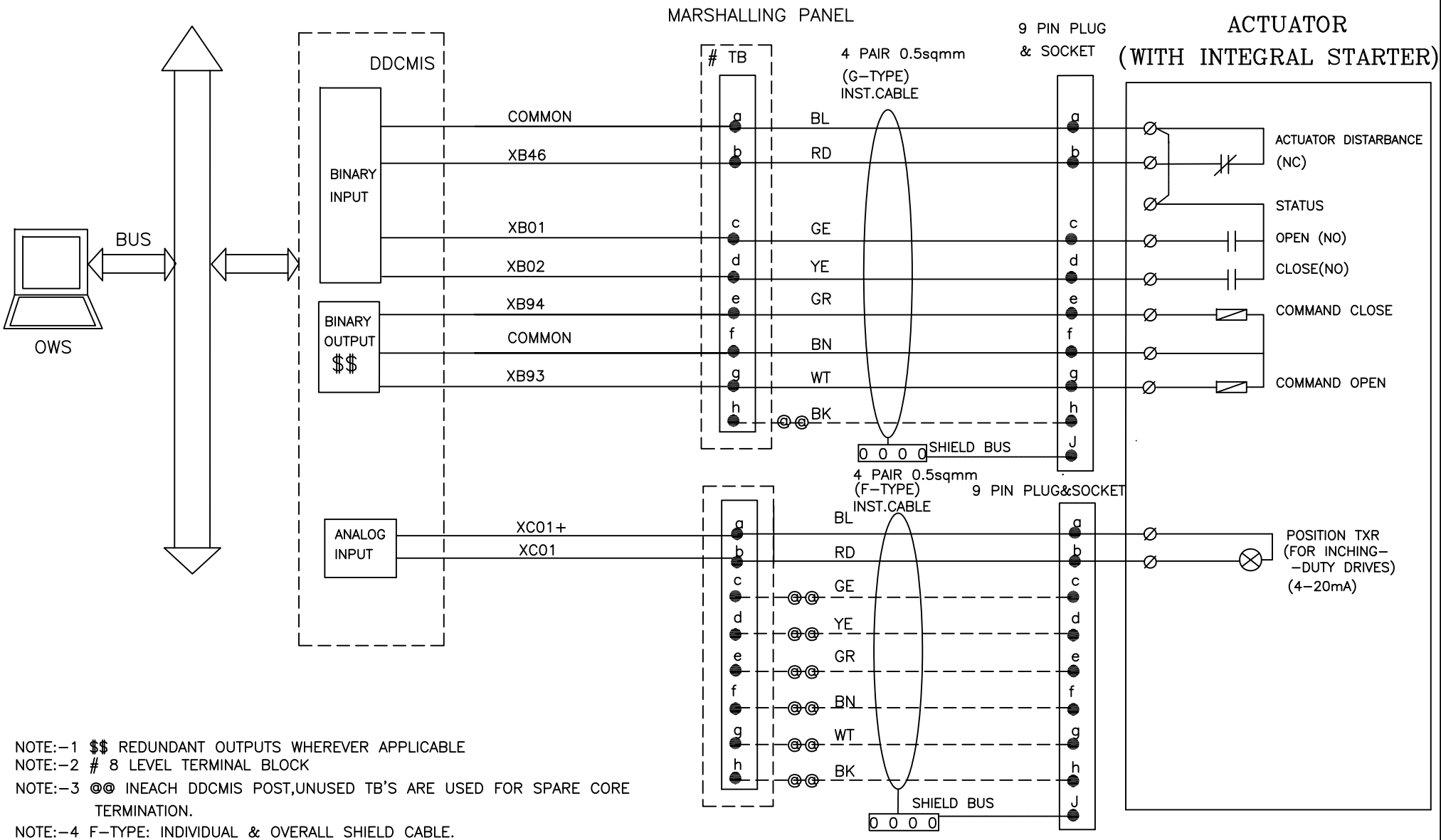


NOTE:-1 $$ REDUNDANT OUTPUTS WHEREVER APPLICABLE
NOTE:-2 # 8 LEVEL TERMINAL BLOCK
NOTE:-3 @@ INEACH DDCMIS POST,UNUSED TB'S ARE USED FOR SPARE CORE TERMINATION.
NOTE:-4 * DISTURBANCE=LOSS OF POWER SUPPLY(1PHASE/3PHASE)/LOSS OF CONTROL SUPPLY/MOTOR THERMOSTAT TRIP/THERMAL OVER LOAD/ TORQUE SWITCH OPERATED, LOCAL/OFF/REMOTE SWITCH IN LOCAL/OFF POSITION

BHEL	UP RAJYA VIDYUT UTPADAN NIGAM LTD 1 X 660 MW PANKI TPS	DRG.NO.	9962-001-PE-405-PVI-B-152
314/500	DDCMIS INTERFACE WITH BID	SHT	06 OF 26

This pg is part of spec PE-TS-426-673A-A001

DDCMIS INTERFACE WITH BIDI/MODI/MOVI

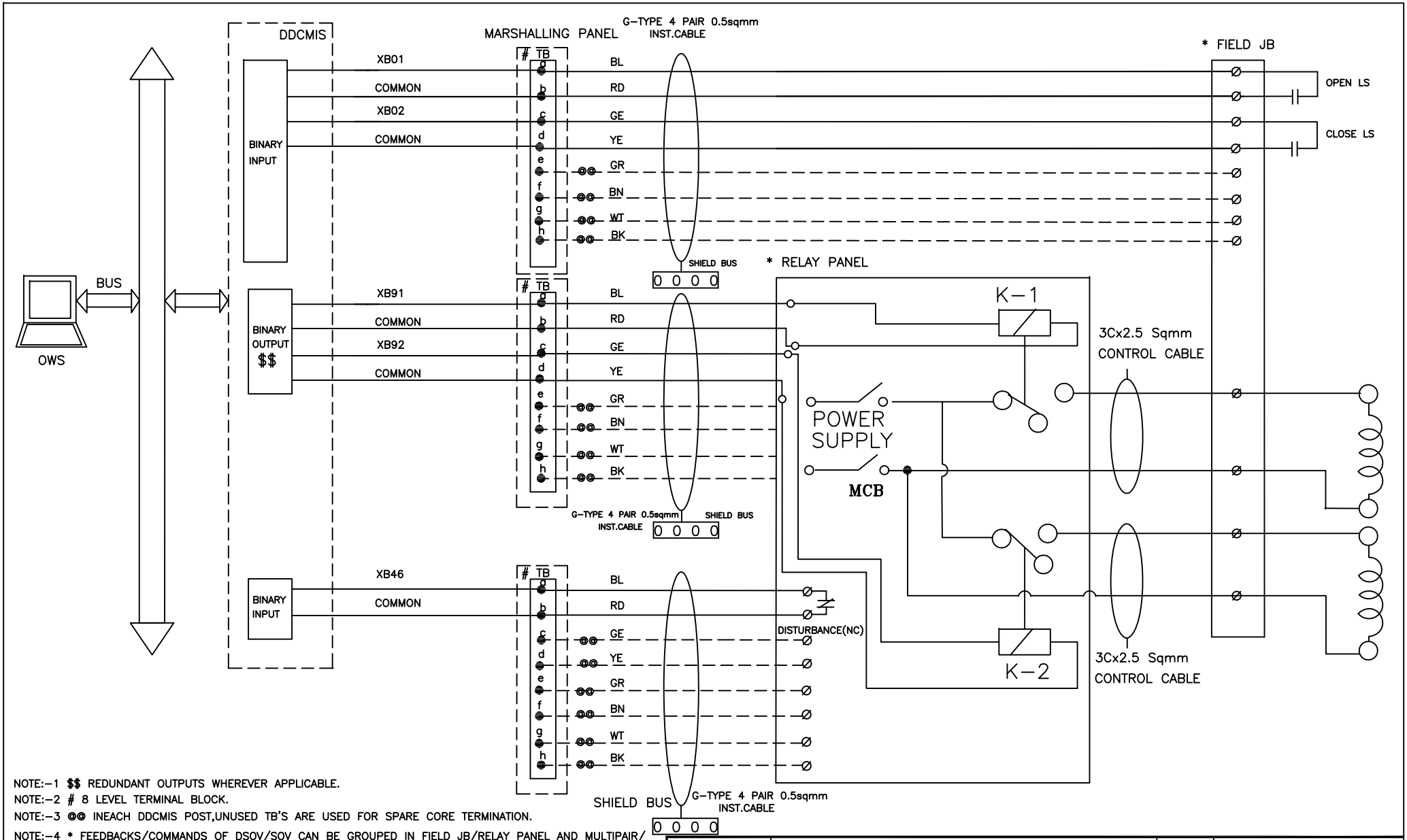


NOTE:–1 $$ REDUNDANT OUTPUTS WHEREVER APPLICABLE
NOTE:–2 # 8 LEVEL TERMINAL BLOCK
NOTE:–3 @@ INEACH DDCMIS POST,UNUSED TB'S ARE USED FOR SPARE CORE TERMINATION.
NOTE:–4 F–TYPE: INDIVIDUAL & OVERALL SHIELD CABLE.
NOTE:–5 *DISTURBANCE=LOSS OF POWER SUPPLY/LOSS OF CONTROL SUPPLY/ MOTOR THERMOSTAT TRIP/THERMAL OVERLOAD/TORQUE SWITCH OPTD/ LOCAL/OFF/REMOTE SWITCH IN LOCAL/OFF POSITION

This pg is part of spec PE-TS-426-673A-A001

BHEL	UP RAJYA VIDYUT UTPADAN NIGAM LTD 1 X 660 MW PANKI TPS	DRG.NO.	9962–001–PE–405–PVI–B–152
315/500	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.

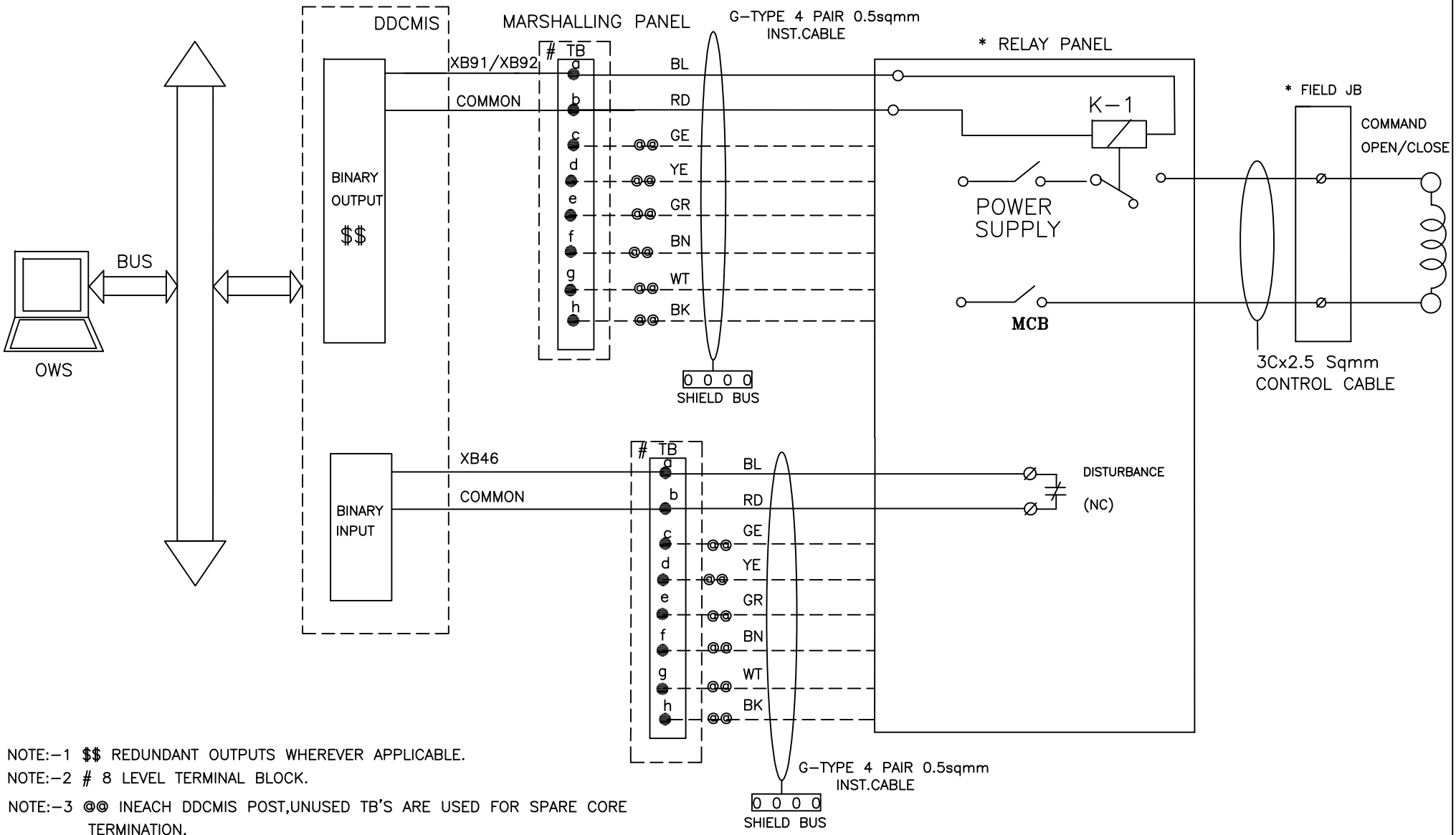
NOTE:-5 FOR ON/OFF TYPE,SOLENOID ACTUATED CONTROL VALVE.

NOTE:-6 TWO INDEPENDENT OUTPUT FROM CONTROL SYSTEM SHALL BE PROVIDED TO PUSH-PULL TYPE VALVES,WITH DUAL COIL SOLENOIDS.

BHEL	UP RAJYA VIDYUT UTPADAN NIGAM LTD 1 X 660 MW PANKI TPS	DRG.NO.	9962-001-PE-405-PVI-B-152
316/500	DDCMIS INTERFACE WITH DUAL COIL SOLENOID (DSOV/L)	SHT	10 OF 34

This pg is part of spec PE-TS-426-673A-A001

DDCMIS INTERFACE WITH SOV/O/SOV/C(WITH OUT FEEDBACKS)



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.

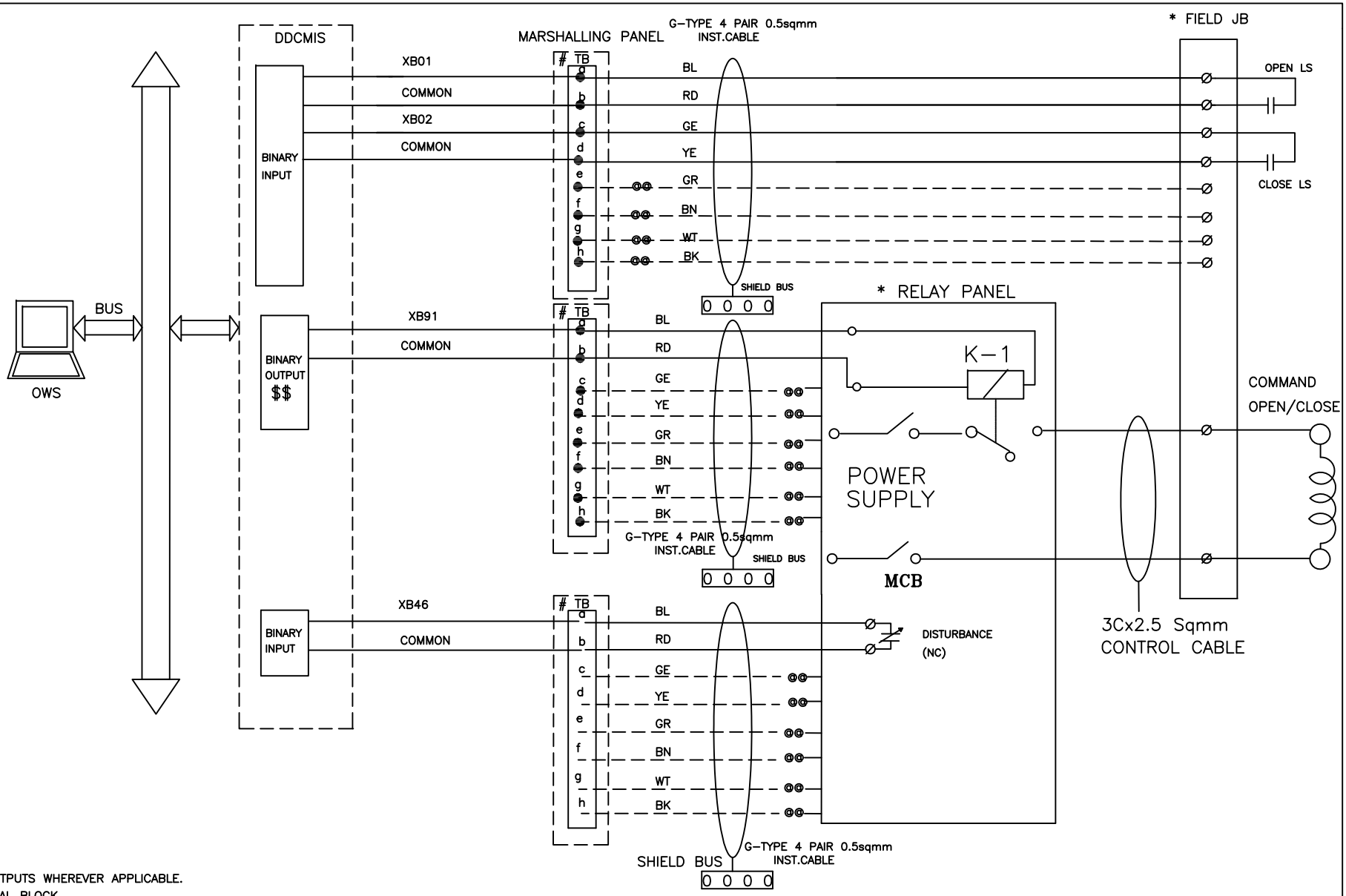
NOTE:-4 * FEEDBACKS/COMMANDS OF DSOV/SOV CAN BE GROUPED IN FIELD JB/RELAY PANEL AND MULTIPAIR/MULTICORE CABLE IS TO BE USED FOR GROUPED SIGNALS FROM FIELD JB/RELAYPANEL TO MARSHELING PANEL.

NOTE:-5 FOR ON/OFF TYPE,SOLENOID ACTUATED CONTROL VALVE.

This pg is part of spec PE-TS-426-673A-A001

BHEL 317/500	UP RAJYA VIDYUT UTPADAN NIGAM LTD 1 X 660 MW PANKI TPS	DRG.NO.	9962-001-PE-405-PVI-B-152
	DDCMIS INTERFACE WITH SOV/O/SOV/C(WITHOUT FEEDBACKS)	SHT	11 OF 34

DDCMIS INTERFACE WITH SOV/O/L(WITH FEED BACKS)

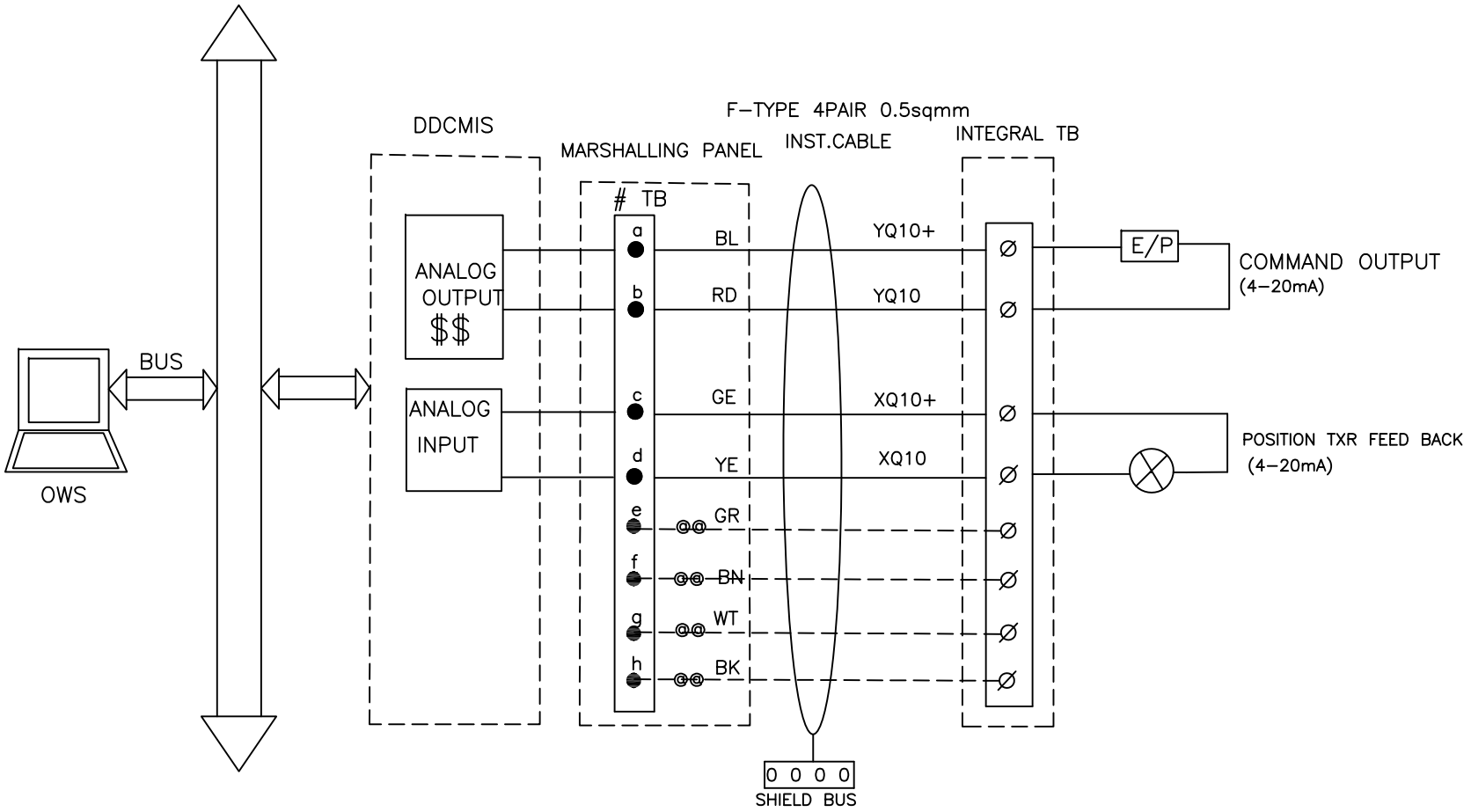


NOTE:-1 $$ REDUNDANT OUTPUTS WHEREVER APPLICABLE.
NOTE:-2 # 8 LEVEL TERMINAL BLOCK.
NOTE:-3 @@ INEACH DDCMIS POST,UNUSED TB'S ARE USED FOR SPARE CORE TERMINATION.
NOTE:-4 * FEEDBACKS/COMMANDS OF DSOV/SOV CAN BE GROUPED IN FIELD JB/RELAY PANEL AND MULTIPAIR/ MULTICORE CABLE IS TO BE USED FOR GROUPED SIGNALS FROM FIELD JB/RELAYPANEL TO MARSHALING PANEL.
NOTE:-5 FOR ON/OFF TYPE,SOLENOID ACTUATED CONTROL VALVE.

This pg is part of spec PE-TS-426-673A-A001

BHEL	UP RAJYA VIDYUT UTPADAN NIGAM LTD 1 X 660 MW PANKI TPS	DRG.NO.	9962-001-PE-405-PVI-B-152
318/500	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

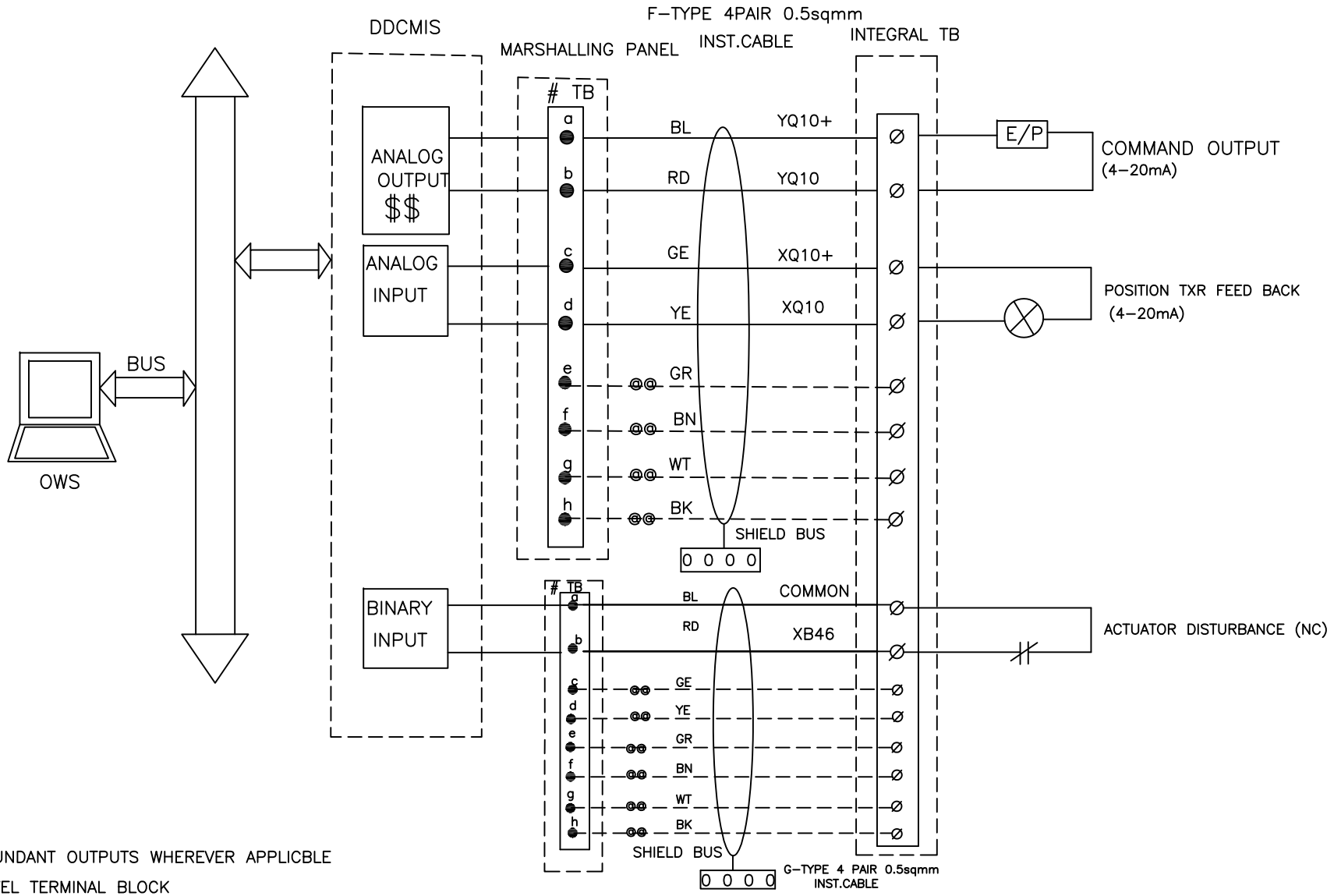
NOTE:–3 @@ IN EACH DDCMIS POST, UNUSED TB's ARE USED FOR SPARE CORE TERMINATION.

NOTE:–4 F–TYPE: INDIVIDUAL & OVERALL SHIELD CABLE.

This pg is part of spec PE-TS-426-673A-A001

BHEL 319/500	UP RAJYA VIDYUT UTPADAN NIGAM LTD 1 X 660 MW PANKI TPS	DRG.NO.	9962–001–PE–405–PVI–B–152
	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

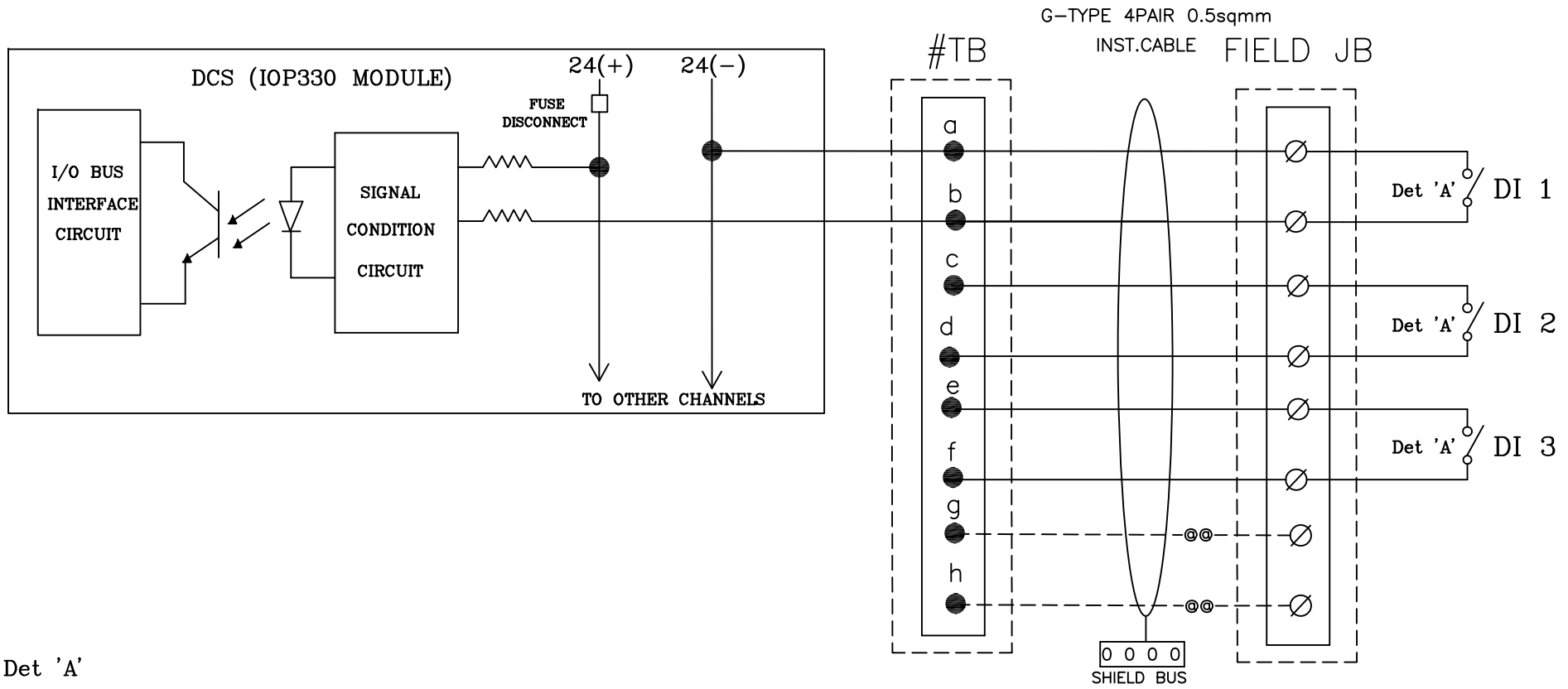
NOTE:–3 @@ IN EACH DDCMIS POST, UNUSED TB's ARE USED FOR SPARE CORE TERMINATION.

NOTE:–4 F–TYPE: INDIVIDUAL & OVERALL SHIELD CABLE.

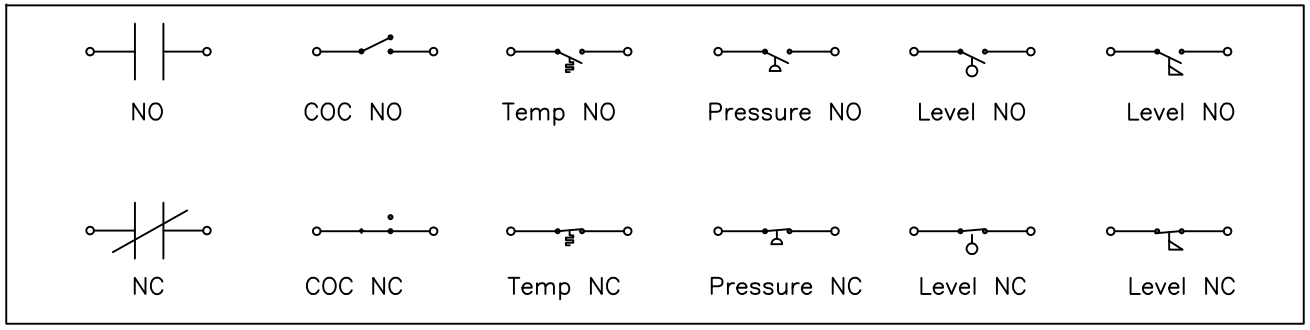
BHEL	UP RAJYA VIDYUT UTPADAN NIGAM LTD 1 X 660 MW PANKI TPS	DRG.NO.	9962–001–PE–405–PVI–B–152
320/500	INTERFACE FOR MODULATING DRIVES – CLCS–M	SHT	15 OF 34

This pg is part of spec PE-TS-426-673A-A001

DDCMIS INTERFACE WITH DIGITAL INPUT SIGNAL



Det 'A'

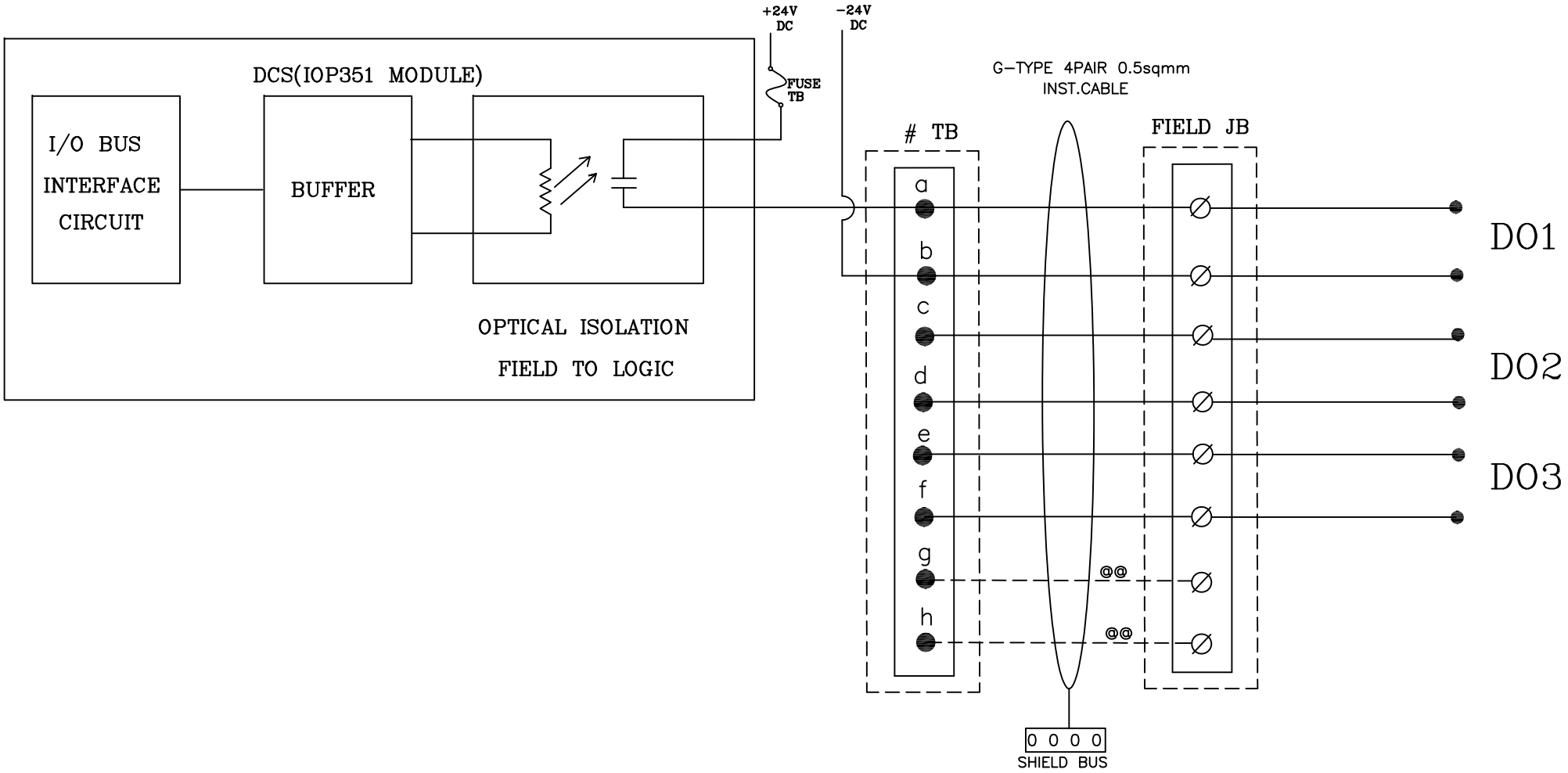


NOTE:–1 #8 LEVEL TERMINAL BLOCK.

NOTE:–2 @@ IN EACH DDCMIS POST, UNUSED TB's ARE USED FOR SPARE CORE TERMINATION.

BHEL	UP RAJYA VIDYUT UTPADAN NIGAM LTD 1 X 660 MW PANKI TPS	DRG.NO.	9962–001–PE–405–PVI–B–152
		DATE	11.02.2019
	DDCMIS INTERFACE WITH DIGITAL INPUT SIGNAL	REV.NO.	01
		SHT	23 OF 34

DDCMIS INTERFACE WITH DIGITAL OUTPUT SIGNAL

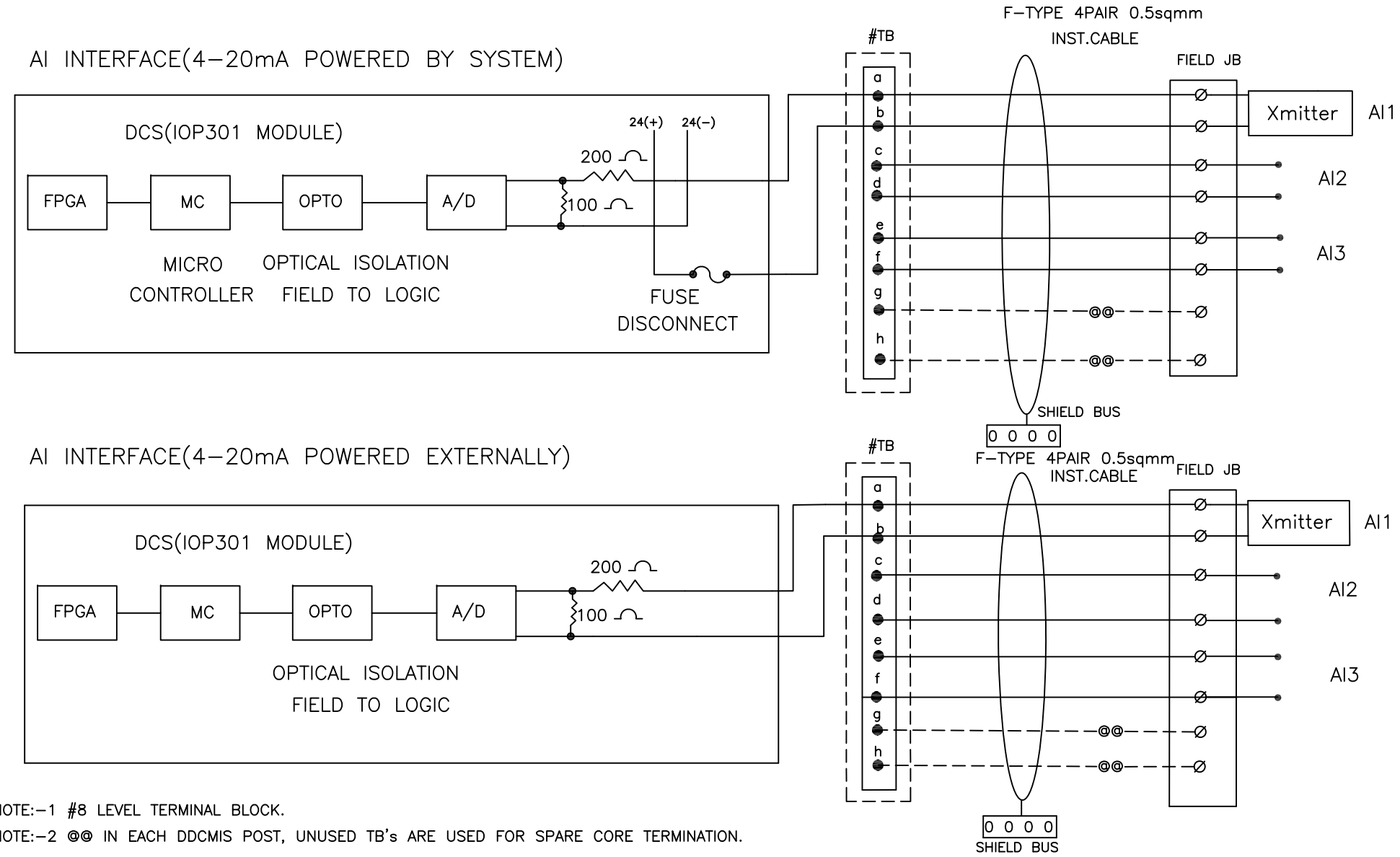


NOTE:-1 #8 LEVEL TERMINAL BLOCK.

NOTE:-2 @@ IN EACH DDCMIS POST, UNUSED TB's ARE USED FOR SPARE CORE TERMINATION.

BHEL	UP RAJYA VIDYUT UTPADAN NIGAM LTD 1 X 660 MW PANKI TPS	DRG.NO.	9962-001-PE-405-PVI-B-152
		DATE	11.02.2019
	DDCMIS INTERFACE WITH DIGTAL OUTPUT SIGNAL	REV.NO.	01
		SHT	24 OF 34

DDCMIS INTERFACE WITH ANALOG INPUT SIGNAL



NOTE:–1 #8 LEVEL TERMINAL BLOCK.

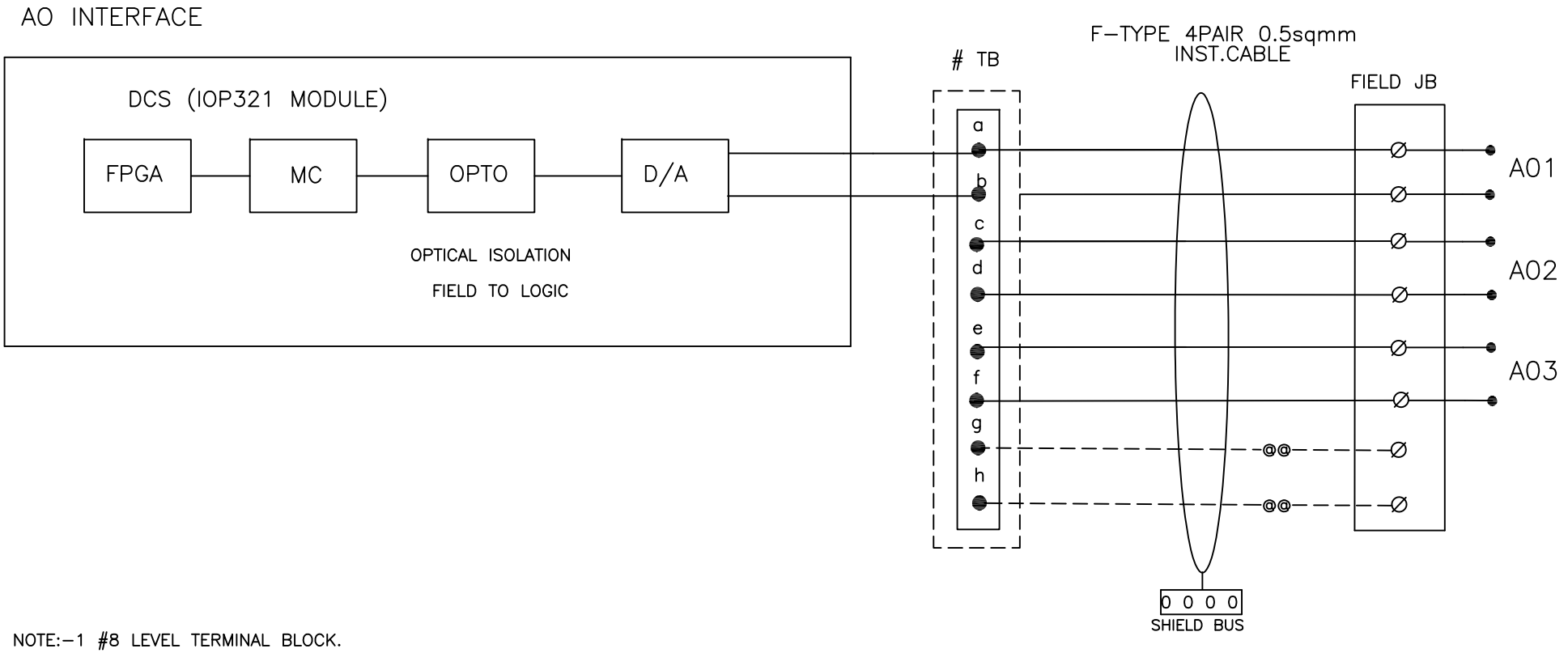
NOTE:–2 @@ IN EACH DDCMIS POST, UNUSED TB's ARE USED FOR SPARE CORE TERMINATION.

NOTE:–3 F–TYPE: INDIVIDUAL & OVERALL SHIELD CABLE.

This pg is part of spec PE-TS-426-673A-A001

BHEL 323/500	UP RAJYA VIDYUT UTPADAN NIGAM LTD 1 X 660 MW PANKI TPS	DRG.NO.	9962-001-PE-405-PVI-B-152
		DATE	11.02.2019
	DDCMIS INTERFACE WITH ANALOG INPUT SIGNAL	REV.NO.	01
		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	UP RAJYA VIDYUT UTPADAN NIGAM LTD 1 X 660 MW PANKI TPS	DRG.NO.	9962-001-PE-405-PVI-B-152
		DATE	11.02.2019
	DDCMIS INTERFACE WITH ANALOG OUTPUT SIGNAL	REV.NO.	01
		SHT	26 OF 34

PROCESS CONNECTION & PIPING

Chapter 8 PROCESS CONNECTION AND PIPING

8.00.00 PROCESS CONNECTION PIPING

8.01.00 The Bidder shall provide, install and test all required material for completeness of Impulse Piping System and Air Piping System as per the requirements of this chapter, enclosed installation drawings and source connection drawings on as required basis for the connection of instruments and control equipments (provided by the bidder) to the process on as required basis for the connection of all instruments and control equipments of entire plant.

The installation and source connection of various items shall generally as per NIT installation drawings (Drawing No. 14A14-DWG-I-0010), however, the bidder shall furnish during detailed Engineering. Installation drawings, GA and fabrication drawings of LIES/LIRs, other relevant drawings, material and tech data sheets of various items service wise for owner's approval/information.

8.01.01 All material, furnished under this chapter and the installation there of shall conform to the latest editions of American National standard Code for pressure piping, power piping ANSI B 31.1, ANSI B16.11, ASME Boiler and pressure Vessel codes, IBR and other applicable ASME, ANSI and state standards.

8.01.02 All material supplied under this chapter shall be suitable for intended service, process, operating conditions and type of instructions used and shall fully conform to the requirements of this specification. The bidder is responsible for the performance of equipments furnished under this specification on system basis. The bidder may offer suggestions for improvement based on his experience, during detailed engineering, which shall be subjected to the Owner's approval.

8.01.01 IMPULSE PIPING, TUBING, FITTINGS, VALVES AND VALVE MANIFOLDS

8.01.02 All impulse pipes shall be of seamless type conforming to ANSI B36.10 for schedule numbers, sizes and dimensions etc. The size of impulse pipe shall be ½" for steam and water applications and ¾" for air and flue gas applications. The material of impulse pipe shall be same as that of main process pipe. For various applications specification of impulse pipe matrials and associated fittings and valves shall be as given in table PCP..

8.01.03 SS tube shall be provided inside enclosures& racks from tee connection to valve manifold and then to instrument. For high pressure/temperature applications (piping class A, B, C & D of the table no PCP) the material shall be ASTM A 213 TP 316H it and for other applications material shall be ASTM A 213 TP 316L. The wall thickness of the tube shall be in accordance with the ANSI B31.1 standard. The bending radius of the tube shall be greater than 6D.

8.01.04 All fittings shall be forged steel and shall conform to ANSI B16.11. The matrial of forged tube fittings for shaped application (e.g. tee, elbow etc) shall be ASTMA 182 Gr 316 H for high pressure/temperature applications (as defined above) and ASTMA 182 Gr 316 L for other applications. The matrial for bar stock tube fitting (for straight application) shall be SS 316.
Metal thickness in the fittings shall be adequate to provide actual bursting strength equal to or greater than those of the impulse pipe or SS tube, with they are to be used.

The source shut off (primary process root valve) and blow down shall be ½ 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. For various applications the valve body materail, stem material and pressure class shall be as given in table 8.1. The end connections of valves shall be of socket welded type unless otherwise specified in the instrument installation diagrams. The disc and seat ring material of carbon Steel and alloy steel valves be ASTM-A-105 and ASTM-A-182 Gr F22, hard faced with satellite (minimum hardness-350 BHN). The surface finish of 16 RMS or grater is required in the area of stem packing. The valve design shall be such that the seats can be reconditioned and stem and disc may be replaced without removing the valve body from the line.

For Pr/D.P. gauges in fluid application two way globe valve on each impluse line to the instrument and in air/flue gas application two way gate valve on each impulse line to the instrument shall be provided near the instrument. These shall be in addition to the three ways gauge cock provided along with the Pressure/Differential pressure gauges.

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 Pipe, Tube (material & rating)	ANSI B31.1, ANSI B31.1a, ANSI/ISA 77.70
Valves (Material Pr. Class, size)	ASTM A 182/ ASTM A 105 as per ASME 16.34
Fitting (Size, rating, material)	ANSI B31.1, ANSI B31.1a, ASME B16. 11-2009
Installation Scheme	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/cm2 or Temp>280 deg C. The end connections of valves shall be of socket welded type.

8.01.03 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 .

8.01.04 Double ferruled compression type fittings shall be used only, wherever required.

8.02.00 **AIR SUPPLY PIPING**

8.02.01 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.

8.02.02 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 drawing no. 14A14-DWG-I-0010.

8.02.03 The Bidder shall also provide and connect pneumatic tubing to E/P convertors and then to control valves. For individual supply line and control signal line to control valve, 1/4-inch size light drawn tempered PVC coated copper/SS tubing conforming to ASTM B75 shall be used. It shall be at least 0.065 inch. The fittings to be used with copper/SS tubes shall be of cast brass/SS, screwed type. 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.

8.02.04 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 with isolation valve from the instrument air and service air terminal points. In the boiler/turbine area the 2 inch head shall be provided upto most elevation of boiler/turbine floor and from this 2 inch header, 1 inch sub header shall be branched off at each floor with isolation valve. From this 1 inch sub-header, branch line of ½ inch, with isolation valve shall be provided upto various devices. Similar system is to be followed for service air required for intermittant purging in the local instrument enclosures (LIEs) 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. The filter regulators shall be suitable for 10 kg/cm2 max. Inlet pressure. The filter size shall be 5 microns and of material sintered bronze. The air set shall have 2 inch size pressure gauge and built in filter housing blow down valve. The end connection shall be ¼ inch/1/2 inch / 3/4 inch NPT as per the requirement to be finalised during detailed engineering.

8.02.05 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.

8.02.06 Purge Air Connection for Air & Flue Gas applications

The continuous purging with instrument air shall be done, for all air and flue gas measurements, at the process source connection end. Necessary arrangements required for continiuous purging shall be provided inside all instruments enclosures and instrument racks for Aot and flue gas applications.

For intermittent purging with service air, necessay arrangements inside al the air and flue gas enclosures shall be provided. The SS316 four ways valve provided in the SS316 tubing shall be used for isolating the transmitter and connecting the srevice air quick disconnect line.

Purging arrangement is not required for instrument air and service air measurement applications. Purge air lines shall be of mild steel hot dipped galvanised inside and outside as per IS1239, heavy duty with threaded ends.

8.03.00 **Process Connections**

The type of instrument source connection shall depend upon the process parameters and the tapping size. The source connection drawings shall be finalised during the engineering stage.

Size of tapping point stub, number and size of root valves for different types of measurements are as follows:

Sl. No.	Quantity of root valves	Size of stub and root valve	Service Condition
Pressure and Differential Pressure Measurement			
(i)	2	25NB	$\geq$ 40 bar(g) OR 425^{0}C
(ii)	1	15NB	< 40 bar (g) AND 425^{0}C.
Level Measurement			
(a)	**Level Gauge & Switch**		
(i)	2	25NB	$\geq$ 40 bar(g) OR 425^{0}C
(ii)	1	25NB	< 40 bar(g) AND 425^{0}C
(b)	**Level transmitter (displacement type)**		
(i)	2	40NB	$\geq$40 bar(g) OR 425^{0}C
(ii)	1	40NB	<40 bar(g) AND 425^{0}C
(c)	**Stand pipe for level measuring instrument**		
(i)	2	80 NB	$\geq$40 bar(g) OR 425^{0}C
(ii)	1	80 NB	< 40 bar(g) AND 425^{0}C
Flow Measurement			
(i)	2	25NB	$\geq$ 40bar(g) OR 425^{0}C
(ii)	1	25NB	< 40 bar(g) AND 425^{0}C
Sampling system measurement (Steam and Water Service)			
(i)	2	25 NB	$\geq$40 bar(g) OR 425^{0}C
(ii)	1	25 NB	< 40 bar(g) AND 425^{0}C

8.04.00 **INSTALLATION AND ROUTING**

8.04.01 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.

Instrument piping & tubing shall not be routed across equipment removal areas, above or below monorails, cranes, removable gratings, cable trays.

For steam and liquid measurements, the impulse pipe should preferably slope downward from source connection to instrument and instrument shall be installed below the source point. If due to any reason instrument is installed above the source point, the impulse pipe should slope upwards continuously and a 'pigtail' should be provided at the instrument to assure water seal for temperature protection. For vacuum measurements instruments shall be installed above source point and impulse pipe should slope upwards.
Impulse piping for air and flue gas shall slope upwards and instrument shall be installed above source point. If this requirement cannot be met special venting or drain provision shall be provided with vent and drain lines along with isolation valves and other accessories including drain pipes this drain is to be connected to plant drain through open funnel also. Horizontal must have a slope of not less than 40 mm per meter and must be adequately supported to maintain a constant slope and to prevent sag in piping.

All impulse piping shall be installed to permit free movement due to thermal expansion, wherein required expansion loops hall be provided.

Special accessories such as condensing pots/reservoirs shall be provided and installed wherever required. In any case condensing pots shall be provided for all level measurements in steam and water services and all flow measurements in steam and water services above 120 Deg. C. For drum level measurement required balancing chamber shall be provided and installed.

Colour coding of all impulse pipes shall be done by the bidder in line with the colour coding being followed for the parent pipes.

Instrument Air & Service Air piping/tubing system

The air supply headers, sub headers and branch pipes shall be supported properly by clamps or supports to be provided and fabricated by the bidder. Air supply piping shall be installed with a slope of over 1/100 to prevent accumulation of condensed water within the pipe. Signal/control air tubing shall run with the minimum number of changes in direction. Suitable identification tags shall be provided for easy link up and checking of proper connections. Single and multi tubes shall run with the minimum number of changes in direction. Suitable identification tags shall be provided for easy checkups and for connections.

PIPING /TUBING SUPPORT

Impulse piping and sample piping shall be supported at an interval not exceeding 1.5 meters. Each pipe shall be supported individually using slotted angle mounted clamps with necessary fixtures. Tubing shall run in proper perforated trays with proper cover. Tubing shall be supported inside the trays by aluminium supports.
Hangers and other fixtures required for support of piping and trays shall be provided, either by welding or by bolting on walls, ceilings and structures. Hanger clamps and other fastening hardware shall be of corrosion resistant

metals and hot-dip galvanised.

8.05.00 **SHOP AND SITE TESTS**

8.05.01 The equipment and work performed as per this chapter shall be subject to shop and site test as per requirements of Vol. II & Vol. V (Quality Assurance & Inspection) other applicable clauses of this chapter and Owner approved quality assurance plan.

8.05.02 Hydrostatic and Pneumatic leakage tests shall be performed on all pipes, tubing and systems and shall conform to ANSI B31.1.

8.05.03 Hydrostatic testing

All instrument piping/tubing shall be hydrostatically tested upon completion of erection. The test pressure shall be 1.5 times the maximum process pressure. The test shall be performed either with the testing of associated process piping or without the associated process piping (by closing the root valve). In both the cases the instrument shall be isolated by closing the shut-off valve.

Air testing

All air headers & branch pipes shall be air tested by pressure decay method as per ANSI B31.1. Flexible hoses ad short signal tubing shall be tested at normal pressure for leakage. Long signal tubing shall be tested by charging each tube with air at 2 Kg/sq.cm through a bubbler sight glass. The boiler draft and vacuum piping shall be air tested by the same method as long signal tubing.

8.06.00 **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.

These local instrument enclosures and racks shall be furnished as per the actual requirements finalised during detailed engineering stage. The exact grouping of instruments in a particular instrument enclosure/instrument rack shall be as finalised during detailed Engineering stage subject to owner's approval. The GA of LIR should be similar to LIE except for front/rear doors and side panels. Vol. V, Part B, Chapter no. 6 shall also be referred for designing of LIE & LIR.

Sufficient spacing among adjacent transmitters shall be maintained to offer easy accessibility and operational convenience. The enclosure shall be designed with sizes to suit the grouping and to completely include all the hardware for hooking up the transmitters to the process on the basis of approved installation diagrams. A maximum of five (5) transmitters are envisaged to be grouped in one enclosure.

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 shall be IP-55.

The enclosure shall be constructed of 1.6 mm sheet plate and shall be of modular construction with one or more modules and two end assemblies bolted together to form an enclosure. Cable glands, Channel and frame shall be 3 mm thick. Double inter locking doors shall be provided. The doors shall be the three point locking type constructed of not less than 1.6 mm thick steel. Doors shall have concealed quick removal type pinned hinges and locking handles. Door locks shall accept the same key.

Neoprene/Polyurethane Gaskets shall be used between all mating sections to achieve protection class of 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.

Bulk heads, especially designed to provide isolation from the process line vibration shall be provided. Exact fabrications details shall be as finalised during detailed Engineering stage. The junction box for LIE/LIR shall conform to IP -65 protection class.

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.

Each Transmitter enclosure housing instruments requiring purge air for continuous air purging, shall be provided with common purge air header, redundant air filters regulators of sufficient capacity , required pressure gauge, valves, fittings, SS tubing and individual purge meters for each purge line etc as required and indicated in instrument installation drawings enclosed herewith.

A 15 mm NB service air header shall be furnished in each instrument enclosure housing air and flue gas and coal mill instruments. The header shall be furnished complete with a pressure regulating valve, pressure gauge and quick disconnect connections. A hose for connecting each header to the draft instrument line four way valves shall be furnished. The hose shall be self storing nylon tubing having a burst pressure of 15 Kg/sq Cm the size of the hose shall be ½ " min. The service air header shall originate at a bulkhead penetration or fitting located on one of the bulkhead plates.

The bidder shall prepare the piping drawings and the general arrangement layout drawings for each of the enclosures and racks. The special attention shall be given in the piping layout to avoid air traps liquid filled piping or water pockets in piping intended to be dry. Drawings shall indicate the arrangement of all equipment, piping, valves and fittings within the enclosures/racks and shall be subject to owner's approval.

All liquid Filled Blow down lines, except those measuring vacuum shall be connected to a two inch header which is extended through one end of the enclosure and turned downward for directing the blow down into a drain. The material of the blow down header shall be carbon steel as per ASTM A 106 Gr C or as indicated in NIT's hookup drawings whichever is better.

The bidder shall submit to the owner with his proposal a copy of his welding procedure specification together with proof of his compliance with the latest applicable welding ANSI code. Prior to any welding being performed the bidder shall submit the qualifications of the craftsmen who will perform the work.

Bidder shall provide not more than three variants for LIE/LIR with respect to max. no. transmitters mounted in each LIE/LIR.

Each enclosure shall be provided with universal type 6/16 Amp. power receptacle, light fixture & LED lamps with wire guard and lighting switch etc. Lighting switches shall be door actuated & mounted inside the panel. Outlet box, switch box and device covers shall be of galvanized stamped steel. Light switches and power receptacles shall be installed inside the enclosure on the wall near the latch side of the enclosure door. Light fixtures shall be installed on the ceilings of the enclosures.

Power Supplies for miscellaneous devices shall be provided with 2P MCB located within the enclosures. MCB shall be mounted in Fuse blocks. Nameplates shall be furnished above the MCB blocks, identifying the devices being served.

e) Turbine lube oil pumps

f) Jacking oil pumps

g) Emergency turbine trip push buttons in control room.

h) Boiler turbine: Generator inter-trip which includes the inter connecting cables between:-

- Boiler master fuel trip and turbine trip relays
- Generator trip relays and turbine trip relays
- Generator trip relays and 400 kV circuit breaker
- Generator trip relays and generator field breaker
- Generator trip relays and UAT breakers

i) Fire alarm, annunciation and protection system.

j) Any other system like safety critical circuit, trip protection circuit and for drives required for safe shut down operations of the plant.

9.03.00 INSTRUMENTATION CABLE INTERCONNECTION AND TERMINATION PHILOSOPHY

The cable interconnection philosophy to be adopted shall be such that extensive grouping of signals by large scale use of field mounted group Junction Baxes (JBs) at strategic locations is done and consequently cable with higher numbers of pairs are extensively used between field & Marshalling panels. The details of termination to be followed are mentioned in the given table below:-

Application		**Type of Termination**	
FROM (A)	TO (B)	END A	END B
Valves/Dampers Drives (Integral Junction Box)	Marshalling/ Marshalling- cum Termination Cubicle/ Local group JB	Plug in connector	Post mount cage clamp type
Transmitters, Process Actuated switches mounted in LIE/LIR	Integral Junction Box of LIE/LIR	Plug in connector	Cage clamp (Rail mount type)
RTD heads	Local Junction Box	Plug in Connector	Cage clamp (Rail mount type)
Thermocouple	Local Junction	Plug in Connector	Cage clamp (Rail

	Box		mount type)
Other Field mounted Instruments	Local JB/ Group JB	Plug in Connector	Cage clamp (Rail mount type)
RTD heads	Temperature transmitter	Plug in Connector	Screwed Cage Clamp Type
Thermocouple	Temperature Transmitter	Plug in Connector	Screwed Cage Clamp Type
Local Junction box, Temperature Transmitter, Int. Junction box of LIE/LIR/Group JBs.	Group JB	Cage clamp (Rail mount type)	Cage clamp (Rail mount type)
Local Junction box, Temperature Transmitter, Int. Junction box of LIE/LIR/Group JB/ MCC/SWGR	Marshalling/ Marshalling – cum Termination Cubicles.	Cage clamp (Rail mount type)	Cage clamp (Post mounted type)
Marshalling cubicle/Termination Cabinets	Electronic system Cabinet	Cage clamp (Post mounted type)	Plug-in connector/other system as per Mfr's standard
Marshalling/ Termination System Cabinets	UCD mounted equipments	Cage clamp (Post mounted type)	Plug in Connector/ Cage clamp Type (rail mounted)
DDCMIS/PLC cabinets	OWS, Printer etc.	Plug in connector	Plug in Connector

Notes

1. For Analog signals, individual pair shieldiing & overall shielding & for Binary signals, only overall shielding of iinstrumentation cables shall be provided.

2. Signal and Electrical connection shall be screwed connection with double compression type Nickel-plated brass/SS316 cable glands for Explosion proof area, Flame proof area and high vibration prone area.

3. All screwed connections shall be provided with double compression type Nickel-plated brass/SS316 cable glands.

9.04.00 TERMINAL BLOCKS

For all inputs to the system emanating from the field or other systems, the bidder shall furnish terminals suitable for correct size of field cables.

9.04.01 All outputs going to MCC/SWGR terminal blocks, shall be rated 600 volts minimum and shall have strap screw less terminals suitable for connection of wires with ring tongue type lugs. Standard terminal blocks shall be rail mounted screw less spring loaded cage clamps type.

The terminal blocks for DDCMIS/DCS/PLC input/output connections from/to SWGR/MCC, Actuators with Integral Starter (for Coupling relays and check back signals of 11 kV and 3.3 kV auxiliaries, LT drives/valves & dampers/solenoids, CT&VT, etc.) shall be provided with built in test and disconnect facilities complete with plug, slide clamp, test socket etc. The exact type of terminal blocks to be provided by the bidder and the technical details of the same including width etc. shall be subject to owner's approval.

Terminal blocks shall be approximately sized for larger wire size of higher voltage insulated incoming conductors as necessary. All the TBs used shall be high quality non-flammable insulating material of melamine suitable for working temperature of 105 deg C and 6.6 polymide to withstand corrosion and the metallic portion shall be coated against rust /corrosion. All metal parts should be non –ferrous in nature.

9.04.02 All the Terminal blocks shall be provided complete with all required accessories including assembly rail, locking pin and section, end brackets, partions, small partions, test plug bolts and test plug (as specified above for SWGR connections) transparent covers, support brackets, distance sleeves, warning label, marking etc.
The marking on terminal strips shall correspond to the terminal numbering on wiring diagrams.

9.04.03 Fuses shall not be mounted on terminal blocks. Neither step type terminal blocks nor angle mounting of terminal blocks will be acceptable.The terminal blocks shall be arranged with at least 100 mm clearance between two sets of terminal blocks and between terminal blocks and junction box walls.

9.04.04 At least 20 per cent spare unused wired terminals shall be provided on each terminal block for circuit modifications and for termination of all conductors in a multi-conductor control cable with each panel, enclosure, cubicle, Junction Boxes, SOV Boxes, instrument racks/enclosures, termination/marshalling cabinets, etc.

All terminal blocks shall be numbered for identification and grouped according to the function. Engraved labels shall be provided on the terminal blocks.

For terminating each process actuated switches, drive actuators, control valves, thermocouples, RTD, etc. in local junction boxes etc. refer NIT's interfacing & wiring drawings.

9.04.05 For ensuring proper connections, Bidder shall provide suitable accessories, along with insulation sleeves. The exact connecting accessory shall be finalised as per application during detail engineering stage subject to owner's approval without any cost repurcussions.

9.05.00 INTERNAL PANELS/ SYSTEM CABINETS WIRING

9.05.01 Internal panel/cabinet wiring shall be of multi-stranded copper conductor with FRLS PVC insulation without shield and outer sheath meeting the requirements of VDE 0815.

9.05.02 All internal wires shall be provided with tag and identification nos. etched on tightly fitted ferules at both ends. All wires directly connected to trip devices shall be distinguished by one additional red colour ferrule.

9.05.03 All external connection shall be made with one wire per termination point. Wires shall not be tapped or spliced between terminal points.

9.05.04 All floor slots of desk/panels/cabinets used for cable entrance shall be provided with removable gasketed gland plates and sealing material. Split type grommets shall be used for prefabricated cables.

9.05.05 All the special tools as may be required for solder less connections shall be provided by Bidder.

9.05.06 Wiring to door mounted devices shall be provided with (49 strand minimum) adequate loop lengths of hinge wire so that multiple door openings will not cause fatigue braking of the conductor.

9.05.07 Power supply wiring, and interconnecting cables between devices shall pass the following tests.

a) Flammability test IEEE 383/1974
b) When tested under UITPP test method or ASTM 2893/77 light transmittance of 80%
c) When tested under IEC 754-1 maximum acid gas generation shall be 2% by weight
d) Oxygen index not less than 30 as per ASTM D 2863.

9.05.08 Following wire size shall be utilized for internal wiring:

a.	Current (4-20 mA) Low voltage signals (AI/AO & DI signals)	:	0.5 sq.mm
b.	DO signals, Ammeter/ voltmeter circuit,control switches, indicator,recorder	:	0.5 sq.mm
c.	Internal Illumination	:	2.5 sq.mm

d. Size of Power supply cables shall be as below:-

	Load	**Size**
i.	1 to 16 Amp.	- 2.5 sq. mm
ii.	17 to 20 Amp.	– 4 sq. mm
iii.	21 to 32 Amp.	- 6 sq. mm

iv. 33 to 40 Amp. - 10 sq. mm.
v. 41 to 60 Amp. - 16 sq. mm

9.06.00 **INSTRUMENTATION CABLE INSTALLATION & ROUTING**

9.06.01 Immediately prior to the installation of each cable or cable group, the raceway route to be followed shall be inspected and ascertained to be complete in installation and free of all materials detrimental to the cable or its placement. All cables assigned to a particular duct/conduit shall be grouped and pulled in simultaneously using cable grips and suitable lubricants. Cables removed from one duct/conduit shall not be reused without approval of Owner.

9.06.02 Cables shall be segregated as per IEEE Std.-422. In vertically stacked trays, the higher voltage cable shall be in higher position and instrumentation cable shall be in bottom tier of the tray stack. The distance between instrumentation cables and those of other system shall be as follows:

From 11 kV/6.6 kV/3.3 kV tray system	-	914 mm
From 415V tray system	-	610 mm
From control cable tray system	-	305 mm

9.06.03 Cables shall terminate in the enclosure through cable glands. All cable glands shall be properly gasketed. Sealing (to prevent ingress of dust entry and propagation of fire) shall be provided for all floor slots used for cable entrance. Double compression cable glands shall be provided.

9.06.04 The cables emanating from redundant equipment/devices shall be routed through different paths. The above segregation of cables & wiring for redundant equipments/devices shall be in accordance with IEEE-Std-422.

9.07.00 **CABLE LAYING AND ACCESSORIES**

1 Cables shall be laid strictly in line with cable schedule.

2 Identification tags for cables.

Indelible tags to be provided at all terminations, on both sides of wall or floor crossing, on each conduit/duct/pipe entry/exit, and at every 20 m in cable trench/tray.

3 Cable tray numbering and marking.

To be provided at every 10m and at each end of cable way & branch connection.

4 Joints for less than 250 Meters run of cable shall not be permitted.

5 Buried cable protection

CHAPTER 5 : GENERAL TECHNICAL REQUIREMENTS

1.0 INTRODUCTION

This part covers technical requirements, which will form an integral part of the Contract. The following provisions shall supplement all the detailed technical requirements brought out in the Technical Specifications and the Technical Data Sheets.

2.0 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 Owner to determine that the products proposed are equivalent or superior to those named.

3.0 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 Bidder 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 may 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 Owner. Sufficient amount of information for justifying such proposals shall be furnished to Owner along with the bid to enable the Owner to determine the acceptability of these proposals.

4.0 COMPLETENESS OF FACILITIES

4.1 Bidders may note that this is a contract inclusive of the scope as indicated elsewhere in the specification. Plant shall be engineered and designed in accordance with the specification requirement. All engineering and associated services are required to ensure that a completely engineered plant is provided.

4.2 All equipments furnished by the Bidder 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 & maintenance 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.

4.3 All similar standard components/ parts of similar standard equipment provided shall be interchangeable with one another.

5.0 Codes & Standards

5.1 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.) Bureau of Indian Standards (BIS)
(b.) Indian Electricity Act (2003)
(c.) Indian Electricity Rules
(d.) Indian Explosives Act
(e.) Indian Factories Act and State Factories Act
(f.) Indian Boiler Regulations (IBR)
(g.) Regulation of Central Electricity Authority
(h.) Regulations of the Central Pollution Control Board, India
(i.) Regulations of the Ministry of Environment & Forest (MoEF), Government of India
(j.) Pollution Control Regulations by Department of Environment, Government of India
(k.) State Pollution Control Board.
(l.) Building and other construction workers (Regulation of Employment and Conditions of services) Central Rules, 1998
(m.) Explosive Rules, 1983
(n.) Petroleum Rules, 1976,
(o.) Gas Cylinder Rules, 1981
(p.) Static and Mobile Pressure Vessels (Unified) Rules, 1981
(q.) Workmen's Compensation Rules, 1924
(r.) Rules for Electrical installation by Tariff Advisory Committee (TAC) and appropriate Electrical Inspectorate.
(s.) Owner's Safety Policy
(t.) Any other statutory codes / standards / regulations, as may be applicable.

5.2 Unless covered otherwise by Indian codes & standards and in case nothing to the contrary is specifically mentioned elsewhere 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.) British Standards (BS)
(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 Organisation for Standardization (ISO)
(i.) Tubular Exchanger Manufacturer's Association (TEMA)
(j.) American Welding Society (AWS)
(k.) Cooling Tower Institute (CTI)
(l.) National Electrical Manufacturers Association (NEMA)
(m.) National Fire Protection Association (NFPA)
(n.) International Electro-Technical Commission (IEC)
(o.) Expansion Joint Manufacturers Association (EJMA)
(p.) Heat Exchange Institute (HEI)
(q.) IEEE standard
(r.) JEC standard

5.3 Other International/ National standards such as DIN, VDI, BS, etc. shall also be accepted for only material codes and manufacturing standards, subject to the Owner's approval, for which the Bidder shall furnish, along with the offer, 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.

5.4 As regards highly standardized 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. In addition, these standards shall be referred for the design of machine foundations, wherever specifically mentioned in the specifications. However, for those of the above equipment not covered by these National / International standards, established and proven standards of manufacturers shall also be considered.

5.5 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.

5.6 Two (2) English language copies of all-national and international codes and/or standards used in the design of the plant, equipment, civil and structural works shall be provided by the Bidder to the Owner within two calendar months from the date of the Notification of Award.

5.7 In case of any change in codes, standards & regulations between the date of bid opening and the date when vendors proceed with fabrication, the Owner shall have the option to incorporate the changed requirements or to retain the original standard. It shall be the responsibility of the Bidder to bring to the notice of the Owner such changes and advise Owner of the resulting effect.

6.0 EQUIPMENT FUNCTIONAL GUARANTEE

6.1 The Equipment and Auxiliaries shall be capable of continuous operation in frequency range of 47.5 to 51.5 Hz.

6.2 The functional guarantees of the equipment under the scope of the Contract shall be as per “Chapter 8 - Functional Guarantee & LD”, Volume-II. These guarantees shall supplement the general functional guarantee provisions covered under General Conditions of Contract.

6.3 Liquidated damages for shortfall in meeting functional guarantee(s) during the performance and guarantee tests shall be assessed and recovered from the Bidder as specified elsewhere in this specification.

7.0 DESIGN OF FACILITIES / MAINTENANCE & AVAILABILITY CONSIDERATIONS

7.1 Design of Facilities

7.1.1 All the design procedures, systems and components proposed shall have already been adequately developed and shall have demonstrated good reliability under similar conditions elsewhere.

7.1.2 The Bidder shall be responsible for the selection and design of appropriate equipments to provide the best co-ordinate 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.

7.2 Maintenance and Availability Considerations

7.2.1 Equipment/facilities 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.

7.2.2 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.

7.2.3 Lifting devices i.e. hoists and chain pulley jacks, etc. shall be provided by the Bidder for handling of any equipment or any of its part having weight in excess of 500 Kgs during erection and maintenance activities.

7.2.4 Lifting devices like lifting tackles, slings, etc. to be connected to hook of the hoist / crane shall be provided by the Bidder for lifting the equipment and accessories covered under the specification.

8.0 DOCUMENTS, DATA AND DRAWINGS TO BE FURNISHED BY BIDDER

8.1 Plant and equipment shall be fully integrated, engineered and designed to perform in accordance with the technical specification. All engineering and technical services required ensuring a completely engineered plant shall be provided in respect of mechanical, electrical, control & instrumentation, civil & structural works as per the scope.

The Contractor shall furnish engineering data/drawings in accordance with the schedule of information as specified in Technical Specification and data sheets.

A comprehensive engineering and quality coordination procedure shall be finalized with the successful bidder covering salient features as described in this section of specifications.

8.2 The number of copies/prints/CD-ROMs/manuals to be furnished for various types of documents is given in Annexure-I attached with Chapter 5, Volume-II.

8.3 The documentation that shall be provided by the Bidder is indicated in various sections of specification. The documentation shall include but not be limited to the following:

8.3.1 Basic Engineering Documentation

Prior to commencement of the detailed engineering work, the Bidder shall furnish a Plant Definition Manual within 4-6 weeks from the date of the Notification of Award. This manual shall contain the following as a minimum:-

1) System description of all the mechanical, electrical, control & instrumentation & civil systems.

2) Technology scans for each system / sub-system & equipment.

3) Selection of appropriate technology / schemes for various systems/ subsystems including techno-economic studies between various options.
4) Optimization studies including thermal cycle optimization.

5) Sizing criteria of all the systems, sub-systems including various piping systems/ equipments/ structures/ equipment foundations along with all calculations justifying and identifying the sizing and the design margins.

6) Schemes and Process & Instrumentation diagrams for the various systems/ sub-system with functional write-ups.

7) Operation Philosophy and the control philosophy of the Main Plant and other plants.

8) General Layout plan of the power station incorporating all facilities in Bidder's as well as those in the Owner's scope. This drawing shall also be furnished in native (Word, Excell, ACAD etc) in the form of CD discs to the Owner for engineering of areas not included in Bidder's scope.

9) Basic layouts and cross sections of the main plant building (various floor elevations), boiler, fuel oil area and other areas included in the scope of the Bidder.

10) 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 Owner.

After approval of Plant Definition Manual / Design Basis Report, Bidder shall furnish detailed technical specification of all system / packages of the Plant.

8.3.2 Detailed Engineering Documentation

1) Layouts, general arrangements, elevations and cross-sections drawings for all the equipment and facilities of the plant.

2) Flow diagrams, Process & Instrumentation Diagrams along with write-up and system description.

3) Start-up curves for turbine, boiler and both turbine and boiler combined together as a unit for various start-ups, viz. cold, warm and hot start-up.

4) Piping isometric, composite layout and fabrication drawings.

5) Piping engineering diagrams, pipe and fittings schedules, valve schedules, hanger and support schedules, insulation schedules.

6) Technical data sheets for all bought out and manufactured items. Bidder shall use the specifications as a base for placement of orders on their sub-vendors.

7) Detailed design calculations for components, system/sub-system, piping etc., wherever applicable including sizing calculations for all auxiliaries as per criteria specified elsewhere in specification.

8) Boiler pressure part schedule and sizing calculations. Boiler performance data and boiler design dossier.

9) Transient, hydraulic and thermal stress analysis of piping and system wherever applicable & input and output data along with stress analysis isometrics showing nodes.

10) Thermal cycle information (heat balance diagrams, boiler performance calculations, condenser and heat exchanger thermal calculations etc.).

11) Characteristic Curves/ Performance Correction Curves. Hydraulic & Mechanical design calculations for condensers & heaters.

12) Model Studies/ CFD analysis for ESP, CW sump etc and furnishing report with recommendations.

13) Characteristic Curves/ Performance Correction Curves and thermal design calculations for Cooling Tower.

14) Composite Water Balance for total Plant.

15) Hydraulic calculation/profile for Water Treatment Plant.

16) Comprehensive list of all terminal points which interface with Owner's facilities giving details of location, terminal pressure, temperature, fluid handled & end connection details, forces, moments etc.

17) Power supply single line diagram, block logics, control schematics, electrical schematics, etc.

18) Protection systems diagrams and relay settings. Load Flow study.

19) Interconnection diagrams.

20) Cable routing plan.

21) 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.

22) Alarm and annunciation list and alarms & trip set points.

23) Sequence and protection interlock schemes.

24) Type test reports and power system stability study report.

25) Control system configuration diagrams and card circuit diagrams and maintenance details.

26) Detailed software manuals & source software listing.

27) Detailed flow chart for digital control system.

28) Mimic diagram layout.

29) Civil Task drawings (for the Engineering by Owner), Design and Drawings for the Civil & Structural works in the scope of the Bidder.

30) Model study reports wherever applicable.

31) Functional & guarantee test procedures and test reports.

32) Documentation in respect of Quality Assurance System as listed out elsewhere in this specification.

33) Documentation in respect of commissioning as listed out elsewhere in this specification.

The Bidder while submitting the above documents / drawings for approval / reference as the case may be, shall mark on each copy of submission the reference letter along with the date vide which the submissions are made.

8.3.2 Instruction Manuals

The Bidder shall submit to the Owner, 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 finalization and approval of the Owner 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 Owner. The Instruction Manuals shall comprise of the following.

A) Erection Manuals

The erection manuals shall be submitted at least three (3) months prior to the commencement of erection activities of particular equipment/system. The erection manual should contain the following as a minimum.

1) Erection strategy.

2) Sequence of erection.

3) Erection instructions.

4) Critical checks and permissible deviation/tolerances.

5) List of tool, tackles, heavy equipments like cranes, dozers, etc.

6) Bill of Materials

7) Procedure for erection.

8) General safety procedures to follow during erection/installation.

9) Procedure for initial checking after erection.

10) Procedure for testing and acceptance norms.

11) Procedure / Check list for pre-commissioning activities.

12) Procedure / Check list for commissioning of the system.

13) 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) <u>Chapter 1 - Plant Description</u> :

To contain the following sections specific to the equipment/system supplied

i.) Description of operating principle of equipment / system with schematic drawing / layouts.

ii.) Functional description of associated accessories / controls. Control interlock protection writes up.

iii.) 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).

iv.) Exploded view of the main equipment, associated accessories and auxiliaries with description. Schematic drawing of the equipment alongwith its accessories and auxiliaries.

v.) Design data against which the plant performance will be compared.

vi.) Master list of equipments, Technical specification of the equipment/ system and approved data sheets.

vii.) Identification system adopted for the various components, (it will be of a simple process linked tagging system).

viii.) Master list of drawings (as built drawing - Drawings to be enclosed in a separate volume).

2) <u>Chapter 2.0 - Plant Operation:</u>

To contain the following sections specific to the equipment supplied

i.) Protection logics provided for the equipment alongwith brief philosophy behind the logic, Drawings etc.

ii.) Limiting values of all protection settings.

iii.) Various settings of annunciation/interlocks provided.

iv.) Start-up and shut down procedure for equipment alongwith the associated systems in step mode.

v.) Do's and Don'ts related to operation of the equipment

vi.) Safety precautions to be taken during normal operation. Emergency instruction on total power failure condition/lubrication failure/any other conditions.

vii.) Parameters to be monitored with normal value and limiting values.

viii.) Equipment isolating procedures.

ix.) Trouble shooting with causes and remedial measures.

x.) Routine testing procedure to ascertain healthiness of the safety devices alongwith schedule of testing.

xi.) Routine Operational Checks, Recommended Logs and Records

xii.) Change over schedule if more than one auxiliary for the same purpose is given.

xiii.) System/plant commissioning procedure.

xiv.) Preservation procedure on long shut down.

3) <u>Chapter 3.0 - Plant Maintenance</u>

To contain the following sections specific to the equipment supplied

i.) Exploded view of each of the equipments. Drawings alongwith bill of materials including name, code no. & population.

ii.) 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

iii.) List of Special T/ P required for Overhauling /Trouble shooting including special testing equipment required for calibration etc

iv.) 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.

v.) Preventive Maintenance schedules linked with running hours/calendar period alongwith checks to be carried out

vi.) Overhauling schedules linked with running hours/calendar period alongwith checks to be done

vii.) Long term maintenance schedules

viii.) Consumables list alongwith the estimated quantity required during normal running and during maintenance like Preventive Maintenance and Overhauling

ix.) 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

x.) Tolerance for fitment of various components

xi.) Details of sub vendors with their part no. in case of bought out items

xii.) List of spare parts with their Part No, total population, life expediency & their interchange ability with already supplied spares to OWNER.

xiii.) List of mandatory and recommended spare list along with manufacturing drawings, material specification & quality plan for fast moving consumable spares.

xiv.) Lead time required for ordering of spares from the equipment supplier, instructions for storage and preservation of spares

xv.) 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.

8.3.2.2 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.

8.3.2.3 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.

8.3.3 Plant Handbook and Project Completion Report

8.3.3.1 Plant Handbook

The Bidder shall submit to the Owner 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

1) Design and performance data.

2) Process & Instrumentation diagrams.

3) Single line diagrams.

4) Sequence & Protection Interlock Schemes.

5) Alarm and trip values.

6) Performance Curves.

7) General layout plan and layout of main plant building and auxiliary buildings.

8) Important Do's & Dont's

The plant handbook shall be submitted within twelve (12) months from the date of award of contract. After the incorporation of Owner's comments, the final plant handbook complete in all respects shall be submitted three (3) months before start-up and commissioning activities.

8.3.3.2 Project Completion Report

The Bidder shall submit a Project Completion Report at the time of handing over the plant.

8.3.4 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 (GTR)-Vol-II.

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 (GTR), Vol-II.

iv) The completed plant documentation including integrated 3-D model with equipment drawings, data sheets, P&ID, BOQ, schematics, logic diagrams, test reports and quality plan, etc. attached to the respective equipments / systems in the 3D model shall be furnished to Employer,

along with the design review software (network ready) which shall include interference check, walk-through animation, simulation, visual effect, photo realism etc. loaded on a server with four (4) work stations (latest configuration for server & workstation) with one A4 size colored laser printer and one A0 size colored plotter. The software shall include facility for obtaining hard copies of all the drawings/documents on standard plotter / printer.

The requisite hardware and software shall be supplied and commissioned by the Contractor at Employer's Head Office at Lucknow & Site Office at Panki as per mutually agreed schedule.

All softwares provided shall necessarily include the cost for perpetual license(s) for use on all the machines and an Annual Maintenance Contract (AMC) which shall include software upgrades as & when released by the software agency for a period of three (3) years after warranty/guarantee period.

b) All documents/text information shall be in latest version of MS Office or MS Excel 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 sub vendors) 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 subvendor) 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.

f) 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".

g) 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

h) 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.

i) 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.

j) 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.

k) 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.

l) 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 Owner prior to erection. Small diameter pipes shall however be routed as per site conditions in consultation with site authority/representative of Owner based on requirements of such piping indicated in approved / finalized 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 package.

m) Assessing & anticipating the requirement and supply of all piping and equipment shall be done by the Bidder 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.

n) As Built Drawings

After final acceptance of individual equipment/system by the Owner, the Bidder will update all original drawings and documents for the equipment/ system to “as built” conditions in requisite number.

o) Drawings must be checked by the Bidder in terms of its completeness, data adequacy and relevance with respect to engineering schedule prior to submission to the Owner. In case drawings are found to be submitted without proper endorsement for checking by the Bidder, the same shall

not be reviewed and returned to the Bidder for re-submission. The Bidder 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 Bidder 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 Owner's scope and submit all necessary drawings/ documents for the same.

p) The Bidder shall submit adequate prints of drawing/data/document for Owner's review and approval. The Owner shall review the drawings and return one (1) copy to the Bidder 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 Bidder to submit/rectify and resubmit in time shall not be accepted as a reason for delay in the contract schedule.

q) All engineering data submitted by the Bidder after final process including review and approval by the Project Manager/Owner 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.

8.4 Engineering Information Submission Schedule

Prior to the award of Contract, a Detailed Engineering Information Submission Schedule shall be tied up with the Owner. 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.

a) Information that shall be submitted for the approval of the Owner before proceeding further, and

b) Information that would be submitted for Owner'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.

8.5 Engineering Progress and Exception Report

8.5.1 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 including those for revision after commenting last revision .

8.5.2 The draft format for this report shall be furnished to the Owner within four (4) weeks of the award of the contract, which shall then be discussed and finalized with the Owner.

8.6 Engineering Co-ordination Procedure

8.6.1 The following principal coordinators will be identified by respective organizations at time of award of contract:

Project Manager (UPRVUNL EC):
Name :
Designation :
Address
a) Postal :
b) Telegraphic /e-Mail :
c) FAX : TELEPHONE (Land & Mobile) :

Contractor's/ Vendor's Engineering Coordinator (VENDOR EC):

Name :
Designation :
Address :
a) Postal :
b) Telegraphic /e-Mail :
c) FAX : TELEPHONE(Land & Mobile) :

8.6.2 All engineering correspondence shall be in the name of above coordinators on behalf of the respective organizations.

8.6.3 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 OWNER'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 Owner 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) Owner shall intimate the contractor, OWNER drawing number procedure. Vendor, thereafter, shall indicate OWNER drawing number in MDL and in subsequent Submission of drawing, in the space provided for this purpose in

title plate, in addition to his own drawing number, if any.

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 Owner'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 Owner. 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 Owner's review and approval. The drawings submitted by the Contractor/vendor shall be reviewed by OWNER 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/action:

CATEGORY/Action - 1 : Distributed
CATEGORY/Action – 2 : Approved

CATEGORY/Action – 3 : Approved, subject to incorporation of comments/ modification as noted. Forward final drawingResubmit revised drawing incorporating the comments

CATEGORY/Action – 4 Approved, subject to incorporation of comments/ modification as noted. Resubmit revised drawing incorporating the comments

CATEGORY/Action – 5: Not approved. Resubmit revised drawings for approval after incorporating comments/ modification as noted in accompanying memo.

CATEGORY/Action – 6 : For information and records.

h) Contractor shall resubmit the drawings marked/stamped under Category/Action 3,4 & 5 within two(2) 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 (e.g. 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 Owner's review and approval. **Drawings resubmitted shall show clearly the portions where the same are revised marking the relevant revision numbers and Owner 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 OWNER 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 shall be the responsibility of the Contractor/ Vendor to get all the drawings approved as the case may be and complete the 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.

m) 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.

9.0 Technical Co-Ordination Meetings

9.1 The Bidder shall be called upon to organize and attend monthly Design/ Technical Co-ordination Meetings with the Owner / Owner's representatives / OWNER Consultant during the period of contract. The Bidder shall attend such meetings at his own cost at mutually agreed venue as and when required and fully co-operate with such persons and agencies involved during the discussions.

9.2 The Contractor should note that Time is the essence of the contract. In order to expedite the early completion of engineering activities, the Bidder shall submit all drawings as per the agreed Engineering Information Submission Schedule. The drawings submitted by the Bidder will be reviewed by the Owner as far as practicable within three (3) weeks from the date of receipt of the drawing .The comments of the Owner shall then be discussed across the table during the above co-ordination Meetings wherein best efforts shall be made by both sides to ensure the approval of the drawing.

9.2.1 The Contractor shall ensure availability of the concerned experts / consultants/ personnel who are empowered to take necessary decisions during these meetings. The Bidder 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.

9.2.2 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.

9.3 Any delays arising out of failure by the Bidder to incorporate Owner's comments and resubmit the same during the TCM shall be considered as a default and in no case shall entitle the Bidder to alter the Contract completion date.

10.0 Design Improvements

The Owner 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 Bidder proceeds with the change. Following such agreement, the provision thereof, shall be deemed to have been amended accordingly.

11.0 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 Owner. Each base plate which 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.

12.0 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.

13.0 Lubricants, Servo Fluids and Chemicals

13.1 The Bidder's scope includes all the first fill and one year's topping, requirements of consumables such as oils, lubricants including grease, servo fluids, gases and essential chemicals etc. Consumption of all these consumables during the initial operation and final filling after the initial operation shall also be included in the scope of the Bidder. Bidder shall also supply a quantity not less than 10% of the full charge of each variety of lubricants, servo fluids, gases, chemicals etc. used which is expected to be utilised during the first year of operation. This additional quantity shall be supplied in separate Containers.

13.2 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 Owner along with lubrication requirements.

14.0 Lubrication & Chemicals

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.

14.1 Chemicals for Water System

Bidder's scope include Chemical required for complete water system up to final handing over EPC package and further two (2) months plant operational requirement.

15.0 Material of Construction

All materials used for the construction of the equipment shall be new and shall be in accordance with the requirements of this specification. Materials utilized for various components shall be those which have established themselves for use in such applications.

16.0 Rating Plates, Name Plates & Labels

16.1 Each main and auxiliary item of plant including instruments 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 Owner.

16.2 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 Owner or as detailed in appropriate section of the technical specifications.

16.3 Such nameplates or labels shall be of white non-hygroscopic 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. The name plates shall be suitably fixed on both front and rear sides.

16.4 Items of plant such as valves, which are subject to handling, shall be provided with engraved chromium plated nameplate or label with engraving filled with epoxy. The name plates for valves shall be marked in accordance with MSS standard SP-25 and ANSI B 16.34 as a minimum.

16.5 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. Suitable scale shall also be provided to indicate load on support/hanger.

16.6 Valves, steam traps and strainers shall be identified by Owner's tag number of a metal tap permanently attached to non pressure parts such as the yoke by a stainless steel wire. The direction of flow shall also be marked on the body.

16.7 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/cm2 (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.

16.8 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.

16.9 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

17.0 Tools and Tackles

The Bidder shall supply with the equipment one complete set of all special tools and tackles and other instruments required 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 Bidder shall also ensure that these tools and tackles are not used by him during erection, commissioning and initial operation. For this period the Bidder should bring his own tools and tackles. All the tools and tackles shall be of reputed make acceptable to the Owner.

18.0 Welding

18.1 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 Owner in advance of commencement of erection work.

19.0 Colour Code for all Equipments/ Pipings/ Pipe Services

19.1 All equipment/ piping/ pipe services are to be painted by the Bidder in accordance with Owner's standard colour coding scheme, which will be furnished to the Bidder during detailed engineering stage.

20.0 Protection and Preservative Shop Coating

20.1 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 non-metallic 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. The parts which are likely to get rusted, due to exposure to weather, should also be properly treated and protected in a suitable manner. 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 Chapter 9, Volume II.

20.2 Preservative Shop Coating

20.2.1 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 with at least two coats of primer.

20.2.2 Transformers and other electrical equipments if included shall be shop finished with one or more coats of primer and two coats of high grade epoxy. The finished colours shall be as per manufacturer's standards, to be selected and specified by the Owner at a later date.

20.3 Shop primer for all steel surfaces which will be exposed to operating temperature below 95 degrees Celsius shall be selected by the Bidder after obtaining specific approval of the Owner 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 Owner.

20.4 All other steel surfaces which are not to be painted shall be coated with suitable rust preventive compound subject to the approval of the Owner.

20.5 All piping shall be cleaned after shop assembly by shot blasting or other means approved by the Owner. Lube oil piping or carbon steel shall be pickled.

20.6 Painting for Civil structures shall be done as per relevant part of technical specification.

21.0 QUALITY ASSURANCE PROGRAMME

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 program to control such activities at all points, as necessary. Such programs 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 program shall be generally in line

with ISO-9001/IS-14001. A quality assurance program of the contractor shall generally cover the following:

a) His organization structure for the management and implementation of the proposed quality assurance program

b) Quality System Manual

c) Design Control System

d) Documentation and Data Control System

e) Qualification data for bidder's key personnel.

f) The procedure for purchase of materials, parts, components and selection of sub-Bidder's services including vendor analysis, source inspection, incoming raw-material inspection, verification of materials purchased etc.

g) System for shop manufacturing and site erection controls including process, fabrication and assembly.

h) Control of non-conforming items and system for corrective actions and resolution of deviations.

i) Inspection and test procedure both for manufacture and field activities.

j) Control of calibration and testing of measuring testing equipment.

k) System for Quality Audits.

l) System for identification and appraisal of inspection status.

m) System for authorising release of manufactured product to the Owner.

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.

22.0 General Requirements - Quality Assurance

22.1 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 Bidder 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 Bidder's responsibility to draw up and implement such programme duly approved by the Owner. The detailed Quality Plans for manufacturing and field activities shall be drawn up by the Bidder and will be submitted to Owner for approval. Schedule

of finalisation of such quality plans will be finalised before award. Monthly progress reports on MQP/FQP submission/approval shall be furnished.

22.2 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 Bidder's/ Sub-Bidder'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 e.g. CD or E-mail in addition to hard copy, for review and approval. After approval the same shall be submitted in compiled form on CD-ROM.

22.3 Field Quality Plans will detail out for all the equipment, the quality practices and procedures etc. to be followed by the Bidder's "Site Quality Control Organisation", during various stages of site activities starting from receipt of materials/equipment at site.

22.4 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 Owner's approval without which manufacturer shall not proceed. These approved documents shall form a part of the contract. In these approved Quality Plans, Owner shall identify customer hold points (CHP), i.e. test/checks which shall be carried out in presence of the Owner's Project Manager or his authorised representative and beyond which the work will not proceed without consent of Owner in writing. All deviations to this specification, approved quality plans and applicable standards must be documented and referred to Owner along with technical justification for approval and dispositioning.

22.5 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 Owner's Project Manager/Authorised representative and duly authorised for despatch by issuance of Material Despatch Clearance Certificate (MDCC).

22.6 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.

22.7 The Bidder shall submit to the Owner Field Welding Schedule for field welding activitiesin the format enclosed at Annexure-V. The field welding schedule shall be submitted to the Owner 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.

22.8 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 Owner.

22.9 All welding/brazing procedures shall be submitted to the Owner or its authorised representative for approval prior to carrying out the welding/brazing.

22.10 All brazers, welders and welding operators employed on any part of the contract either in Bidder's/sub-Bidder'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 Owner.

22.11 Welding procedure qualification & Welder qualification test results shall be furnished to the Owner for approval. However, where required by the Owner, tests shall be conducted in presence of Owner/authorised representative.

22.12 For all pressure parts and high pressure piping welding, the latest applicable requirements of the IBR (Indian Boiler Regulations) shall also be essentially complied with. 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 Unless otherwise proven and specifically agreed with the Owner, welding of dissimilar materials and high alloy materials shall be carried out at shop only.

22.14 No welding shall be carried out on cast iron components for repair.

22.15 All the heat treatment results shall be recorded on time temperature charts and verified with recommended regimes.

22.16 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.

22.17 All plates of thickness above 40mm & all bar stock/Forging above 40mm dia shall be ultrasonically tested. For pressure parts, plate of thickness equal to or above 25mm shall be ultrasonically tested.

22.18 The Bidder shall list out all major items/ equipment/ components to be manufactured in house as well as procured from sub-contractors bought out items (BOI). All the sub-Bidder proposed by the Bidder 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 Bidder and finalised with the Owner, shall be subject to Owner's approval. The Bidder'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 Owner for approval within the period agreed at the time of pre-awards discussion and identified in review category prior to any procurement. Monthly progress reports on sub-Bidder detail submission / approval shall be furnished. Such vendor approval shall not relieve the Bidder from any obligation, duty or responsibility under the contract.

22.19 For components/equipment procured by the contractors for the purpose of the contract, after obtaining the written approval of the Owner, the Bidder's

purchase specifications and inquiries shall call for quality plans to be submitted by the suppliers. The quality plans called for from the sub-Bidder 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 Owner and such approved Quality Plans shall form a part of the purchase order/contract between the Bidder and sub-Bidder. Within 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 Owner on the monthly basis by the Bidder along with a report of the Purchase Order placed so far for the contract.

22.20 Owner reserves the right to carry out quality audit and quality surveillance of the systems and procedures of the Bidder's or their sub-Bidder's quality management and control activities. The Bidder shall provide all necessary assistance to enable the Owner carry out such audit and surveillance.

22.21 The Bidder shall carry out an inspection and testing programme during manufacture in his work and that of his sub-Bidder'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. Bidder 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.

22.22 Quality audit/surveillance/approval of the results of the tests and inspection will not, however, prejudice the right of the Owner 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 Bidder in ensuring complete conformance of the materials/equipment supplied to relevant specification, standard, data sheets, drawings, etc.

22.23 For all spares and replacement items, the quality requirements as agreed for the main equipment supply shall be applicable.

22.24 Repair/rectification procedures to be adopted to make the job acceptable shall be subject to the approval of the Owner/ authorised representative.

22.25 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 number 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 of the total 168 hours of testing, the ambient temperature shall be maintained at 50 deg.C. The equipment shall be interconnected with devices which will cause it 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 deg.C above the ambient temp. at 50 deg.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 48 hours elevated temperature test shall be followed by 120 hours of burn in 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.

In case the Bidder/ sub-Bidder is having any alternate established procedure of eliminating infant mortile components, the detail procedures followed by the Bidder/ sub- Bidder along with the statistical figures to validate the alternate procedure to be forwarded.

22.26 The Bidder/Sub-Bidder shall carry out routine test on 100% item at Bidder/sub-Bidder's works. The quantum of check/test for routine & acceptance test by Owner 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.

23.0 QA Documentation Package

23.1 The Bidder 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.

23.1.1 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.

23.2 Typical contents of QA Documentation are 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 Owner and Bidder for the agreed Customer Hold Points.

h) Certificate of Conformance (COC) wherever applicable.

i) MDCC

23.3 Similarly, the Bidder 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.

23.4 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 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.

23.5 Transmission of QA Documentation

On release of QA Documentation by Inspector, one set of quality document shall be forwarded to Quality Assurance Department (@ Head Office) and other set to respective Project Site of Owner.

For the particular case of phased deliveries, the complete quality document to the Owner shall be issued not later than 3 weeks after the date of the last delivery of equipment.

24.0 Project Manager's Supervision

24.1 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 General Conditions of Contract, the Bidder shall proceed to comply with the Project Manager's decision.

24.2 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 Bidder'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.

25.0 Inspection, Testing and Inspection Certificates

25.1 The word 'Inspector' shall mean the Project Manager and/or his authorized representative and/or an outside inspection agency acting on behalf of the Owner to inspect and examine the materials and workmanship of the works during its manufacture or erection.

25.2 The Project Manager or his duly authorized representative and/or an outside inspection agency acting on behalf of the Owner 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 Bidder shall obtain for the Project Manager and for his duly authorized representative permission to inspect as if the works were manufactured or assembled on the Bidder's own premises or works.

25.3 The Bidder shall give the Project Manager/Inspector fifteen (15) days written notice of any material being ready for testing. Such tests shall be to the Bidder'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 Bidder 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.

25.4 The Project Manager or Inspector shall within fifteen (15) days from the date of inspection as defined herein give notice in writing to the Bidder, 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 Bidder 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.

25.5 When the factory tests have been completed at the Bidder's or sub-Bidder'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 Bidder's test certificate by the Project Manager /Inspector. Project Manager /Inspector to issue such a certificate shall not prevent the Bidder from proceeding with the works. The completion of these tests or the issue of the certificates shall not bind the Owner to accept the equipment should it, on further tests after erection be found not to comply with the contract.

25.6 In all cases where the contract provides for tests whether at the premises or works of the Bidder or any sub-Bidder, the Bidder, 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 authorized representatives to carry out effectively such tests on the equipment in accordance with the

Bidder and shall give facilities to the Project Manager/Inspector or to his authorized representative to accomplish testing.

25.7 The inspection by Project Manager / Inspector and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Bidder in respect of the agreed Quality Assurance Programme forming a part of the contract.

25.8 To facilitate advance planning of inspection in addition to giving inspection notice as specified at clause no 9.05.03 of this chapter, the Bidder 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.

25.9 All inspection, measuring and test equipment used by Bidder shall be calibrated periodically depending on its use and criticality of the test/measurement to be done. The Bidder shall maintain all the relevant records of periodic calibration and instrument identification, and shall produce the same for inspection by the Owner. Wherever asked specifically, the Bidder shall re-calibrate the measuring/test equipment in the presence of Project Manager/Inspector.

25.10 Associated document for quality assurance programme:

25.10.1 List of items requiring quality plan and sub supplier approval. (Annexure-III).

25.10.2 Status of items requiring Quality Plan and sub supplier approval (Annexure-IV)

25.10.3 Field Welding Schedule (Annexure-V).

25.10.4 Manufacturing Quality Plan (Annexure-I).

25.10.5 Field Quality Plan (Annexure-II).

25.11 TESTING OF MAJOR DESIGN FEATURES OF I&C SYSTEM:

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 four 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 fulfil 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 Owner, shall be properly documented and submitted to Owner.

25.12 DEMONSTRATION OF APPLICATION ENGINEERING

2.12.1 Based on UPRVUNL 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).

25.12.2 The above typical cases shall be finalized with the Owner 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 UPRVUNL 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 Owner and demonstrate to Owner at Owner 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 Owner premises & the results shall be documented as part of test report.

25.12.3 During the integrated testing at the Contractor's works, only sample checks shall be done by the Owner for the items covered in above application engineering demonstration.

26.0 PRE-COMMISSIONING, COMMISSIONING, TRIAL OPERATION, PERFORMANCE TEST

26.1 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 Owner and the Bidder 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 Bidder's quality assurance programme as well as those included elsewhere in the Technical Specifications.

b) The Bidder'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) It will be the responsibility of the Bidder to assess and furnish a list of all commissioning spars required for successful commissioning of all the equipment covered under the contract. Such a list shall be furnished by the Bidder within 12 months from the date of LOA, separately for each equipment and shall be reviewed by the Owner and discussed for mutual agreement. The commissioning spares will be so identified as not to allow the trial operation to suffer for want of such commissioning spares. The identification of commissioning spares will not in any way relieve the Bidder of any of his responsibilities of satisfactory performance under the provisions of other conditions of contract. All the commissioning spares shall be deemed to be included in scope of the Bidder as a part of the respective equipment package at no extra cost to the Owner.

d) 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 Owner six months prior to the respective implementations. The Owner will approve final verification of cleanliness.

e) The time consumed in the inspection and checking of the units shall be considered as a part of the erection and installation period.

f) 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 Owner's commissioning (start-up) Engineer(s), should be checked out and cleaned. The checking and inspection of individual systems should then follow a prescribed commissioning documentation [SLs (Standard Check List) / TS (Testing Schedule) / CS (Commissioning Schedule)] approved by the Owner.

g) The Bidder 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.

26.1.1 Bidder shall furnish the commissioning organization chart for review & acceptance of Owner at least eighteen months prior to the schedule date of synchronization of 1st unit. The chart should contain:

a) Biodata including experience of the Commissioning Engineers.

b) Role and responsibilities of the Commissioning Organisation members.

c) Expected duration of posting of the above Commissioning Engineers at site.

26.2 Initial Operation / Trail Operation Test

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 Test shall be considered successful, if during the above period of initial operation, the 660MW unit shall generates a minimum of 451 million kWhrs*, as measured a generator terminals.

c) The Initial Operation shall be considered successful, provided that each item/ part of the facility has 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.

d) The Bidder shall intimate the Owner about the commencement of initial operation and shall furnish adequate notice to the Owner in this respect.

e) Any loss of generation due to constraints attributable to the Owner shall be construed as Deemed Generation.

f) 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 Bidder. 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 Bidder to the full satisfaction of the Owner 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 withholding the aforesaid permission.

(* - shall be appropriately adjusted for any generation loss attributable to Employer.)

26.3 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, to the approval of the Owner shall be used. 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 Owner'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 Bidder, free of cost.

e) The Guarantee tests and specific tests to be conducted on equipments have been brought out in detail elsewhere in the specification.

27.0 TAKING OVER

Upon successful completion of Initial Operations and all the tests (including all PG test) 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 withheld 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.

28.0 TRAINING OF OWNER'S PERSONNEL

28.1 The scope of service under training of Owner shall include a training module in 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 Owner:

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.

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 analysers, CCTV and 24 VDC systems.

h) Training for numerical relays & networking systems supplied under MV & LT switchgear system.

i) Details of training modules for Mechanical, Electrical and C&I systems are given at Annexure – VII,

The exact details, extent and schedule for training shall be as finalised during detailed engineering and shall be subject to Owner's approval.

28.2 The scope of services under training shall also necessarily include training of Owner's Engineering personnel covering a training module as indicated in Annexure – VII. 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 design softwares 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.

28.3 Contractor shall also arrange for training of Employer's personnel in respect of fire detection and protection systems and other Balance of Plant equipments.

28.4 Four (4) man month and two (2) man month training for OWNER Engineering Personnel on the offered CFD modelling code for SG & ESP including alternative geometry modeling technique shall be provided.

28.5 Bidder shall furnish in his offer, details of training module(s) covering above requirements which shall be subject to Owner's approval. Consolidated training period included above (Annexure – VII for O&M and Engineering) is indicative only. Owner reserves the right to reappropriate the training period between O&M and engineering depending upon the details of training module proposed by the Bidder.

28.6 Exact details, extent of training and the training schedule shall be finalised based on the Bidder's proposal within two (2) months from placement of award.

28.7 In all the above cases, wherever the training of Owner's personnel is arranged at the works of the manufacturer's (within Employer's Country) it shall be noted that the lodging and boarding of the Owner's personnel shall be at the cost of Bidder. The Bidder shall make all necessary arrangements towards the same.

28.8 In case the training of Owner's personnel is arranged at the works of the manufacturer's (outside Employer's Country) it shall be noted that the all the expenses including travel, air fare, application processing fees, lodging and boarding of the Owner's personnel shall be at the cost of Bidder. The Bidder shall make all necessary arrangements towards the same.

28.9 Take off prices (product wise) should be indicated by the Bidder in the Bid Proposal Sheets. Owner reserves the right to include or exclude these item(s) during place of Award.

28.10 In addition to above, the contractor shall also arrange for training of 30 Owner's Personnel at a running 660 MW unit on operation of power station, for a period of six (6) months. The training shall be conducted before commissioning of the unit. The lodging and boarding of the Owner's personnel shall be at the cost of Bidder. The Bidder shall make all necessary arrangements towards the same

Note: For training purposes, one (1) man month implies 30 working days (excluding all intervening holidays) per person.

29.0 SAFETY ASPECTS DURING CONSTRUCTION AND ERECTION

In addition to the requirements given in Erection Conditions of Contract (ECC) the following shall also cover:

a) Working platforms should be fenced and shall have means of access.

b) Ladders in accordance with Owner'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.

30.0 Noise level

The equivalent 'A' weighted sound pressure level measured at a height of 1.0 m above floor level in elevation and at a distance of one (1) meter 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

a) Safety valves and associated vent pipes for which it shall not exceed 105 dBA.

b) Regulating drain valves in which case it shall be limited to 90 dBA.

c) TG unit in which case it shall not exceed 90 dBA.

d) For HP-LP bypass valves and other intermittently operating control valves, the noise level shall be within the limit of 85 dBA.

e) Mill noise which will be limited to 85-90 dBA.

31.0 PACKAGING AND TRANSPORTATION

All the equipments & spares 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. Each spare shall be clearly marked or labelled on the outside of the packing with its description. When more than one spare part is packaged in a single case, a general description of the contents shall be shown on the outside of such a case and other packages must be suitably marked and numbered for the purpose of identification. All cases, containers or packages, are liable to be opened for such examination as may be considered reasonable by the Engineer. In case of equipment supplied with grease/lubricants from imported origin, the supplied shall clearly indicate the indigenous equivalent of the grease/lubricant and source of supply so as to enable the Owner to procure these items from indigenous sources. 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 Bidder shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. The Bidder shall ascertain the availability of Railway wagon sizes from the Indian Railways or any other agency concerned in India well before effecting dispatch of equipment. Before dispatch 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 & pre-assembly to bare minimum. The Owner's Inspector shall have right to insist for completion of works in shops before dispatch of materials for transportation.

32.0 ELECTRICAL EQUIPMENTS/ENCLOSURES

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 specification.

33.0 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.

33.1 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:

a)	Temperature	-	Degree centigrade (deg C)
b)	Pressure	-	Kilograms per square centimeter (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.
c)	Draught	-	Millimeters of water column (mm wc).
d)	Vacuum	-	Millimeters of mercury column (mm Hg) or water column (mmWcl).
e)	Flow (Gas)	-	Tonnes/ hour
f)	Flow (Steam)	-	Tonnes/ hour
g)	Flow (Liquid)	-	Tonnes / hour
h)	Flow base	-	760 mm Hg. 15 deg.C
i)	Density		Grams per cubic centimeter.

33.2 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 plug-in connection at rear.

33.3 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 tropicalized & components shall be of industrial grade or better.

34.0 ELECTRICAL NOISE CONTROL

The equipment furnished by the Bidder shall incorporate necessary techniques to eliminate measurement and control problems caused by electrical noise. Areas in Bidder'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-801- 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.

35.0 SURGE PROTECTIONS 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.

36.0 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. shall be as per the details furnished elsewhere.

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.

37.0 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 Bidder 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 Bidder.

a) Temperature test pockets with stub and thermowell.

b) Pressure test pockets

38.0 SYSTEM DOCUMENTATION (DDCIMS)

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 Owner 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 "Technical 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.

38.1 Bill of material (instrument list) for all C&I equipment/ devices shall be furnished by the bidder in standard formats as approved by the Owner.

39.0 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.

40.0 ENVIRONMENTAL MONITORING & CONTROL MEASURES

40.1 The Power Plant will be developed based on the guidelines of the State Environmental Authorities and that of MoEF. Suitable provisions will be incorporated in the design of buildings, structures, and selection of equipment, so that there are no adverse effects due to emissions, noise, and contamination of soil, water and air.

40.2 One single flue stack of 275 meter will be provided for 660 MW unit for wider dispersion of pollutant as per environmental guidelines.

41.0 LIST OF CODES AND STANDARDS

←--- Indian Standards --→ Title	← International and international → recognized 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 1-1952	BS 449:1969 BS 5950 ASA A57,
IS: 807 Code of practice for design, manufacture, erection and testing (Structural portion) of cranes and hoists 6588 (Issued by Standards Association of Australia) DIN 120:1936 (Sheet 1) DIN 120:1936 (Sheet 2) 327 part-I, 1951 BS 466 part-II, 1960 BS 644:1960BS 1757:1951 BS 2573:part-I:1960	Draft Revision, 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 Canadaearthquake) for buildings and structures Leading standards (issued by Canadian Standard) DIN-1055-1955 (Issued by ASA)	National Building code of (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 performance 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 determination of thermal conductivity of thermal insulation materials (two slab guarded hot plate method)	DIN 52612 (Deutscher Normenausschuss) 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 monocrystallines 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 monorystallines 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	Standard No. 1 to IPCEA (USA) Pub.

	cables 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	Methods of testing for rating of forced circulation air cooling and air heating coils.
ASHRAE-52-76	Air cleaning device used in general ventilation for removing particle matter.
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 liquefied 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 refinery 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 (Part I to IV)	Code of practice for concrete structures for the storage of 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/Sec.7)	National Building Code- Structural design of prefabrication and

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	Copperalloy 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.

Roof 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 - Publication	Ministry of Surface Transport (Roads Wing), Specifications for road and bridge works.
IS:73	Specification for paving bitumen

Loadings

IS:875 (Pt. I to V)	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 & 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 (Part I & II)	Safety code for scaffolds and ladders.
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 ferritc 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 ITEM : SUB-SYSTEM:	QP NO.: REV.NO: DATE: PAGE: .... OF....	PROJECT : PACKAGE : CONTRACT NO. : MAIN-SUPPLIER :

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.

MANUFACTURER/ SUB-SUPPLIER	MAIN-SUPPLIER
SIGNATURE	

LEGEND: * RECORDS, INDENTIFIED WITH "TICK" (√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION.** **M:** MANUFACTURER/SUB-SUPPLIER **C:** SUPPLIER/NOMINATED INSPECTION AGENCY, **N**: THE OWNER **P:** PERFORM **W**: WITNESS AND **V:** VERIFICATION. AS APPROPRIATE, **CHP:** THE OWNER SHALL IDENTIFIED IN COLUM "N"

FOR THE OWNER USE

DOC. NO.:
REV..... CAT.....

REVIEWED BY	APPROVED BY	APPROVAL SEAL

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....	

S. 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.

		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 THE OWNER FQA, **'B'** SHALL BE WITNESSED BY OWNER'S ERECTION / CONSTRUCTION DEPTT. AND **'C'** SHALL BE WITNESSED BY ERECTION SUPPLIER (A & B CHECK SHALL BE OWNER CHP STAGE)		DOC. NO.: REV…… REVIEWED BY / APPROVED BY / APPROVAL SEAL
MANUFACTURER / SUB-SUPPLIER	MAIN-SUPPLIER		FOR THE OWNER USE	
SIGNATURE				

ANNEXURE-III

	Project : Stage : : **Package :** **Supplier :** **Bidder 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

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

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

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

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

2. **QP/INSPN CATEGORY**:

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

CAT-II: For these items the Quality Plans approved by the Owner. However no physical inspection shall be done by the Owner. The final acceptance by the Owner 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 the Owner 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

	Project : Stage : Package : Bidder : Bidder 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/I I/I	Propose d Sub-suppliers	Place of manufacturin g works	Approval Status	Sub-supplier detail submission schedule	Remarks

ANNEXURE-V

	Project : Stage : Bidder : Bidder No. : System :	**FIELD WELDING SCHEDULE** **(To be raised by the Bidder)** **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

ANNEXURE-VI
DOCUMENTS DISTRIBUTION SCHEDULE

S.No.	Description of Document	DESEIN				UPRVUNL			
		HO		SITE		HO		SITE	
		HC	CC	HC	CC	HC	CC	HC	CC
1.	Drawings, Data Sheets, Calculation, all equipment / Instrument Schedule, BOM etc. a) For Approval b) Resubmission c) For Information	6*	1	-	-	2	1	-	-
2.	Final Approved Documents	2	1 + 1 CD	1	1	1	1 + 2 CD	4	1 + 1 CD
3.	Drawings / Documents 'As Built'	2	1 + 1 CD	1	1	2	1 + 2 CD	4	1 + 1 CD
4.	Type Test Reports (Initial)	4*	1 + 1 CD	-	-	2	1 + 2 CD	-	-
5.	Type Test Report (Final)	2	1 + 1 CD	1	1	2	1 + 2 CD	4	1 + 1 CD
6.	Piping / Equipment Analysis (Transient) etc., Model Study Report (Draft) including Input / Output date etc.	4*	1	-	-	2	1 + 1 CD	-	-
7.	Piping / equipment Analysis (Transient) etc. Model Study Report (Final Approval) including Input / Output date	2	1 + 1 CD	-	-	2	1 + 2 CD	2	1 + 1 CD
8.	Erection Manual (Draft)	3*	1CD	-	-	1	1CD	-	-

S.No.	Description of Document	DESEIN				UPRVUNL			
		HO		SITE		HO		SITE	
		HC	CC	HC	CC	HC	CC	HC	CC
9.	Erection Manual 'Final'	1	1CD	1	-	1	1CD	2	1CD
10.	O&M Manual 'Draft'	3*	1CD	+	-	1	1CD	-	-
11.	O&M Manual 'Final'	1	1CD	1	-	1	1CD	2	2CD
12.	Commissioning Procedure 'Draft'	3*	1CD	-	-	1	1CD	-	-
13.	Commissioning Procedure 'Final'	1	1CC	1	-	1	1CD	2	1CD
14.	PG Test Procedure "Draft"	3*	1	-	-	1	1	-	-
15.	PG Test Procedure 'Final'	1	1 + 1 CD	1	-	2	1 + 1 CD	2	1 + 1CD
16.	Progress Report	3	1CD	1	-	2	1CD	1	1CD
17.	PG Test Report for Approval	4*	1	-	-	2	1 + 1 CD	-	-
18.	Approved PG Test Report	1	1 + 1 CD	1	-	2	1 + 1 CD	4	1 CD
19.	Project Completion Report	1	1 + 1 CD	1	-	1	1CD	1	1CD
20.	Vendor Details in respect of proposed vendors including Contractor's evaluation Report	1	1CD	-	-	1	1CD	-	-
21.	Monthly Vendor / QP Approval Status	1	1	-	-	2	1	1	1
22.	Manufacturing QPs, Field QPs for review / comments	6*	1	-	-	2	1CD	-	-
23.	Manufacturing QPs, Field QP, Final	1	1CD	1	-	2	1CD	2	1CD
24.	QA documents Package for equipment / field activities etc.	1	1CD	1	-	1	1CD	1	1CD

*	-	Consultant will return one (1) commented document to Vendor and CE (UPRVUNL), Lucknow
HC	-	Hard Copy
CC	-	Soft Copy thru e-mail
CD	-	CD ROM
HO	-	Head Office of Consultant / UPRVUNL

ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
STEAM GENERATOR	Thermal design and hydraulic circulation balance	Familiarization with various system and equipment	Manufacturing processes of pressure parts, and equipments	Control philosophy operation, notices, logic & protection schemes, O&M manual familiarization O&M issues
	Combustion and Air & gas weight calculation	Performance data collect-ion analysis and review	Welding process	
	Pressure part calculation	O&M feed back	Testing facilities	Familiarization of special maintenance techniques.
	Pressure part and strength calculation	Operation history of various equipment and system	Product development in process	Special tool and tackles familiarization
	Tube metal temp. Calculation and selection.	Failure analysis	Future plan for technology induction	
	Performance calculation		R&D work in-progress	
	Duct design.			
	Pressure part			
	Equipment and system sizing and selection of mills, fans, airpreheater, soot blowers, dampers, valves heater, soot blowers, dampers, valves, feeders, burners start-up system, fuel firing system, draft plant			
	Flow scheme development of air & flue gas, fuel oil, auxiliary steam, main and reheat steam feed water.			

ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
	Layout of overall plant, steam generator area, pressure part arrangements, platforms, equipment, piping and duct, coal pipe, flue gas ducts, bunker arrangement, valves and damper, ESP area, cable & piping tressels etc.			
	Erection strategies, erection procedures			
	Performance and demonstration tests.			
MANDAYS	**120**	**20**	**20**	**20**
CFD model development and validation for Steam Generator	Familarisation of fundamentals and basis for the development of the CFD models.			
	Solving of set of simple problems by Owner's engineers with the help of trainer.			
	Hands on experience on the development of detailed/realistic CFD models for the steam generator and ESP. The Bidder/trainer shall develop CFD models for SG & ESPas per the Contract requirement with complete association of the Owner's engineers.			
	Validation of the above CFD model for SG & ESPby Bidder in association with the Owner's Engineers.			
MANDAYS	**120 for SG and 60 for ESP**	**-**	**-**	**-**

ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	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 behaviour 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 specific project.			
	Selection of nos., type and arrangement of bearings, load calculation on bearings, bearing oil flow calculation			
	Selection, design and control principle for Turbine governing system			

ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
	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	Manufacturing process of various components of BFP	
	Criteria for selection of boiler Feed Pump parameters	Data collection of BFP parameters and configur-ation	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, thermal shock, dry run, visual cavitation, string test, axial thrust measurement	
	Impeller design and its hydraulic behavior	O&M history/problems related to BFP	Product development in process	
	Role of critical para- meters such as NPSH(R), Suction specific speed, running clearances, speed etc. in design of feed pumps	Comparative studies for various types of BFP& its features	Future plan for technology induction	
	Material selection of BFP components		R&D work in progress	
	Guiding factors for selection of BFP seals			

ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
	Computation of axial thrust under various flows			
	Performance calculation			
	Transient analysis in pump suction piping wrt NPSH margin			
	Latest technological trends in BFP design			
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	
	Techno economic studies for Selection of condenser tube material and other parts depending on water quality	Collection of data for analysis of availability of Condenser	Testing capability at works	
	Condenser support selection & design	O&M history/problems related to condenser	Product development in process	
	Sizing of condenser w.r.t. super critical units		Future plan for technology induction	
	Latest technological trends in condenser arrangement and design		R&D work in progress	
	Condenser vacuum system design			
MANDAYS	**10**	**5**	**5**	
Feed Regene-rative Equipment'	Thermal and mechanical design calculation of heaters	Comparative studies of salient features	Manufacturing process of various components of heaters	
	Basis of selecting horizontal/vertical	Analysis of data	Assembly	

ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
s	heaters			
	Selection of TTD and DCAs for various heaters, and their effect on turbine heat rate	O&M history/problems related to heaters	Testing capability at works	
	Configuration of HP heaters (2x50% v/s100% capacity		Product development in process	
	Sizing criteria for De- aerator/Heaters		Future plan for technology induction	
	Selection of tube & tube sheet material of heaters		R&D work in progress	
	Latest technological trends in heaters design			
MANDAYS	**15**	**10**	**10**	
3-dimen-sional CFD modelling	CFD model develop ment and validation of design data for steam turbine, BFP, CEP, condenser, heaters etc.			
MANDAYS	**20**			
Training for Balance of Plant Equipment	**120**	**40**	**40**	**40**
	The details of training modules for various BoP equipments & systems shall be decided during detailed engineering.			

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	Operational feedback		
MANDAYS	**16**	**6**		
DDCMIS-Man Machine Interface System Engineering & Application Software	Specific system customization Various system modules & interface with OS Database organization & development Development of mimics Other application like calculations, logs historical storage functionalities & use	Operation feedback		
MANDAYS	**40**	**6**		
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	**20**	**5**	**10**	

ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
DDCMIS-Control system Application Software	Database structure Organisation & inter- face between application program & database	Operational feedback	System integration & System capabilities testing	
	Application for implementation of Control functions			
	Study of standard algorithms & development of new algorithms			
MANDAYS	**12**	**4**	**4**	
DDCMIS - Control Loop Study	General description of closed loop controls of thermal power plant	Specific operational feedback		
	Critical analysis of few control loops e.g., TSCS Stress Control boiler start-up control etc.			
MANDAYS	**4**	**2**		
DDCMIS-Burner Management System	Hardware logic, NFPA/ VDE requirements other safety standard Flame scanner location	Operational feedback	Manufacturing procedure& precautions for handling the system System testing facilities	
MANDAYS	**10**	**3**	**3**	
DDCMIS - EHTC, Turbine stress control system,	Basic design concept& features Logics of turbine stress control system	Operational feedback	Manufacturing procedure & precautions for handling for handling the system System testing facilities	

ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
Turbine protection system& ATRS	Implementation of failsafe philosophy in turbine protection system			
MANDAYS	**10**	**3**	**3**	
Furnace and Flame Viewing System.	Theory & principle of operation Details of software & methods of modification/ customisation	Operational feedback		
Misc. systems for SG/TG C&I				
Electric Power Supply System	Theory & design features		Manufacturing/assembly process	
Wherever "DDCMIS" is indicated, it will mean SG C&I part of DDCMIS, which is in Contractor's Scope.				
QUALITY ASSURANCE & INSPECTION **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.	Operational feedback Co-relationn of reliability and performance of the equipment with implementation of QA system. Appreciation of use of	Appreciation of implementation of QA Programmes in various manufacturing, assembly and testing activities. Appreciation of developmental	

ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
		structured Engg./QA documentation during Operational phase of plant and during RLA studies of plant	activities for new processes and vendors. System of prequalification of special processes	
	System of structured documentation of Engg. And test records			
MANDAYS	**16**	**3**		
PLC	Hardware organization		Manufacturing process of PLC hardware	
	Operating system features		Integration & testing facilities	
	Data base organization			
	Logic/loop algorithm			
	Development of control logic & loop s/w & MMI application development			
MANDAYS	**16**	**-**	**2**	
Electric Power Supply System (UPS & 24 V DC system)	Theory & design features		Manufacturing/assembly process	
			Testing methodology	
MANDAYS	**10**	**2**		
PRODUCT	**AREAS OF TRAINING REQUIREMENT**			
(ELECTRICAL) GENERATOR	(a) Design aspects of the following areas	- Operational feed back	(a) Manufacturing process for	

ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
	- Insulation system	- Familarisation with different sub-systems	- Core	
	- Cooling medium & arrangement		- Winding bars	
	- Winding & core support systems		- Assembly	
	b) Design aspects of other auxiliary systems		(b) Testing facilities	
MANDAYS	**30**	**15**	**15**	
Generator Excitation System including AVR.	Design features of various sub-systems	- Operational feed back	- Manufacturing process& testing facilities for various equipment of excitation system	
	Excitor	- Familiarisation with various equipment functioning at reference plants		
	PMG			
	Transformer			
	Controllers & different limiters etc.			
	PSS & associated system studies			
400 KV Switchyard Equipments			Concepts and operational aspects for the offered equipments	
Substation Automation System				Training for site personnel for operation, maintenance & troubleshooting of total system for 5 working days at UPRVUNL site
MV AND LT Switchgear: Numerical relays & Switchgear SCADA system	Numerical relay engineering & associated training for relay software & O&M SCADA system design, engineering & associated training for SCADA & O&M			

ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
MDBFP motor CW motor & BWCP motor	Design criteria for the stator core and winding, rotor core & winding, Insulation system & Cooling arrangement Study of forces & vibration Diagnostic & testing of large Electrical machines	Operational feedback	Manufacturing process & testing facilities	
MANDAYS	**30**	**15**	**15**	
Boiler Feed pump H.T. Motor	Design Criteria for the Stator core & wdg Rotor core & wdg Insulation system Cooling arrangement	Operational feed back	Manufacturing process & test facilities	
MANDAYS	**10**	**5**	**5**	
CRITICAL PIPING & POWER CYCLE PIPING	Design familiarization for critical piping of supercritical Plant	Familiarization with feedback (in super critical plant) on failure analysis and vibration analysis of piping.	Cold Setting of spring hanger	
	Optimization study for sizing including pressure drop calculation and selection of single or double lead together with Owner's engineers	Study of Feed back regarding hanger setting strategies and practice	Cyclic tests carried on spring hangers.	
	Design and stress analysis of lines with Expansion Joints together with Owner's engineers		Cyclic tests carried on expansion joints	

ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
	Design and stress analysis of piping systems with two phase flow involving Owner's engineers		Manufacturing process of critical piping components and appreciation of their testing facilities at shop	
	Transient analysis and optimum sizing of feed suction piping together with Owner's engineers.			
	Static and dynamic analysis of critical piping including siesmic and other occassional load analysis (safety valve blowing condition). A joint activity together with Owner's engineers.			
	Study and collection of data pertaining to special welding requirements (pre and post weld heat treat ment and electrode selection criteria etc.) of materials used in high temp piping system.			
	Study and collection of data on special requirements in case of welding dissimilar metals and electrode selection criteria			
MANDAYS	**45**	**10**	**10**	

ANNEXURE-VII		
Area	**Topics**	**Mandays**
DDCMIS-Man Machine Interface-Hardware & Operating System	Hardware & Software organization of the system	20
	Basis of selection of H/W memory sizing	
	Operating system features, interface with other system, openness & inter-operability	
	Upgradeability	
	System testing Features	
	Trouble shooting & fault analysis	
DDCMIS-Man Machine Interface System Engineering & Application Software	Specific system customization	40
	Various system modules & interface with OS	
	Database organisation & development	
	Development of mimics	
	Other application like calculation, logs historical storage functionalities & use	
	Trouble shooting & fault analysis	
DDCMIS-Control System Hardware & Control System Application Software	Basic design features for system & its modules Manufacturing process 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 & 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	5
	Testing methodology	
	Trouble shooting and fault analysis	
SWAS	Theory & design features	5
	Trouble shooting and fault analysis	
Communication System	Theory & design features	4
	Trouble shooting and fault analysis	
PSSS System	Theory & design features	5
	Trouble shooting and fault analysis	
QA SYSTEM & PROGRAMME	Integrated QA Management system for enhanced reliability of equipments	10
	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	
Controls & Instruments	Familiarization with control system and instrumentation	20
	QA System for manufacture of reliable components. Manufacturing activities for critical instruments/items	
	Implementation of testing programme to ensure reliability	
Simulator	a. System design structure and basis of design b. Hardware components and their configuration c. System Software and Simulation Software Tools d. Plant process modelling and DCS emulation e. Project specific application development, configuration and modifications including equipment modelling and interconnections of models, graphics development , configuring equations etc, f. Maintenance and troubleshooting of hardware and software components	24

PADO	Theory & design features	**10**
	Trouble shooting and fault analysis	
CEMS	Theory & design features	5
	Trouble shooting and fault analysis	
AAQMS	Theory & design features	5
	Trouble shooting and fault analysis	
C&I Lab Instruments	Theory & design features	6
	Trouble shooting and fault analysis	
DMS	Theory & design features	5
	Trouble shooting and fault analysis	
Station LAN & MIS	Theory & design features	5
	Trouble shooting and fault analysis	
Note	**One week shall constitute of five (5) man days.**	

CHAPTER 12: SEWAGE TREATMENT PLANT

12.0 SEWAGE TREATMENT PLANT

12.1 The sanitary waste streams from the different buildings of the plant shall be collected by gravity into the respective manholes. The sewage shall flow from the manholes to the nearest collection chambers by gravity. The collected sewage in the collection chambers shall flow through sewer lines and flow to the common collection sump . From the common collection sump the sewage shall be pumped to the equalization Tank located in the STP Area.

The sewage treatment plant shall be designed as per guidelines of CPHEEO Manual. The anticipated no. of users shall be 1000 persons. The sewage treatment plant shall be designed to handle a flow of 40Kld considering average per capita consumption of 45lpcd with 80% of used water generated as sewage. The Sewage Treatment Plant shall be modular type based on FAB/MBBR technology followed by disinfection by Hypo and necessary tertiary treatment prior to reuse in horticulture purpose.

The finally treated sewage shall meet the norms of environment protection rules 1986 and its amendments and the rules of State Pollution Control Board. The Flow Diagram of Sewage Collection & Conveyance with treatment facility have been outlined in Drg No. 14A14-DWG-M-027 (Rev.0)

The major areas as sources of sanitary waste water shall be:

- STG Building
- Service Building
- Transformer Yard
- Switch Yard
- Compressed Air Building/ DG Room
- ESP Control Room
- Ash Water & Slurry Pumphouse & Ash Water Recovery & Compressor Area
- CW & ACW Pump House
- Canteen
- Workshop Building
- Fire Station Building
- DM plant, CPU Regeneration & N.Pit
- Fuel Oil Pump House & Tank Area
- Crusher House
- CHP Control Room
- Raw Water Pump House
- Ware House
- Security & Time Office

} Isolated Locations

SNO.	Source of Waste water	No. of persons	Qty of waste Generated (m3/day) Tentative	Disposal to
A.	**FROM PLANT BUILDINGS**			
1	STG Building	150	5.4	Main Sewer line
2	Service Building	50	3.5	Main Sewer line
3	Transformer Yard	20		
4	DG Room Building	10		
5	Switch yard	15		
6	CW & ACW Pump House	25	10	Main Sewer line
7	Canteen	150		
8	Workshop Building	100		
9	Fire Station Building	25	1.6	Main Sewer line
10	DM plant , CPU Regn & N.pit Area	20		
11	ESP Control Room	20	3.0	Main Sewer line
12	Ash Water & Slurry Pump House	40		
13	Clarifier Ash water Recovery	10		
14	Ash Compressor House	10		
15	Pre Treatment Plant	60	2.2	
16	F.O. Pump House & Tank Area & Unloading Area	40	1.5	
17	Ash Control Room at silo area	10	0.36	
18	Ash water clarifier area Control Room	10	0.36	
19	Hydrogen generation control room	10	0.36	
20	Wagon tippler control room	10	0.36	
B.	**FROM ISOLATED LOCATIONS**			
1.	CHP control Room	75	1.0	Septic Tank(ST-I)
2.	Raw Water pump House	15	0.5	Septic Tank(ST-II)

3.	Intake pump House	10	0.36	Septic Tank(ST-IV)
4.	Administrative Building	50	8.0	Septic Tank(ST-III)
5.	Ware House	100		
6.	Security& Time office	15		
	Total No. of users	1000		

The quantum of sewage generated at the isolated locations of the plant being minimal shall be collected in the respective manholes and finally flow to the septic tanks by gravity wherein the partial treatment shall be provided, and partially treated sewage shall be treated with online hypo dosing prior to being reused in the nearby areas for horticulture.

All the sewer lines shall be designed such that the self cleaning velocity is maintained and the materials to be used for sewer lines shall be RCC NP3 pipe. The manholes shall be located at intersections along the sewer line at every change in direction and the maximum spacing of 30 meters in straight stretches to facilitate the mantainence of sewer lines.Sewer lines shall be designed considering peak factor as per guidelines of CPHEEO manual and shall run at 0.5 full at ultimate peak flow.

12.2 The Sewage treatment plants shall consist of following treatment components:

- One (1) no. Common Collection Sump complete with all accessories.
- Two (2X 100%) nos. Common Collection Sump Pumps complete with all accessories.

❖ Preliminary Treatment:

- Coarse Screens for screening incoming serwage
- Oil & Grease Trap
- One (1) no. Equalization cum holding tank complete with all accessories.
- Two (2X 100%) nos. FAB Feed Pumps complete with all accessories.
- Two (2X 100%) nos. Air Blowers for Equalization Tank complete with all accessories.

❖ Aeration System:

- One (1) no. FAB Tank complete with all accessories. Aerobic Biological treatment in the FAB Tank with fine bubble diffused aeration. From the FAB tank, partially treated sewage shall be further transferred to the Clarfication system.

- Two (2X 100%) nos. Air Blowers for FAB Tank complete with all accessories.

❖ Clarfication System:
- One (1) no. Tube Settler complete with all accessories. Settling of digested sludge in the Tube Settler.
- One (1) no. Hypo Contact Cum Filter Feed Tank complete with all accessories. Treated water from Settler transferred & stored in the Hypo Contact Cum Filter Feed Tank
- Two (2X 100%) nos. Filter Feed Pumps complete with all accessories.
- One (1) no. Sodium Hypochlorite Dosing Tank complete with all accessories.
- Two (2X 100%) nos. Sodium Hypochlorite Dosing Pumps complete with all accessories.

❖ Sludge Handling Sytem:
- One (1) no. Sludge (from aeration tank & clarifier) Sump with all accessories.
- Two (2X 100%) nos. Sludge Transfer Pumps complete with all accessories.
- One (1) no. centrifuge along with drives and solid cake disposal system including pipes, chutes, valves etc. including dumper trucks. One (1) no. Polyelectrolyte Dosing Tank complete with all accessories.
- Two (2X 100%) nos. Polyelectrolyte Dosing Pumps complete with all accessories.

❖ Tertiary Treatment:
- One (1) no. Dual Media Filter with all accessories.
- One (1) no. Activated Carbon Filter with all accessories.
- One (1) no. Treated Water Tank with all accessories.
- Two (2X 100%) nos. Treated Water Disposal Pumps complete with all accessories.

❖ Bidder shall provide all the consumable including chemicals till the Trial Run Operation of the plant and additional chemicals of one (1) month requirement.

12.3 INLET/OUTLET PARAMETERS FOR STP

SNo.	Parameters	Unit	Inlet Parameters	Guaranteed Parameters
1.	pH		7.0 - 8.0	7.5-8.5
2.	BOD	ppm	300	<=10
3.	COD	ppm	600	<=30100
4.	Oil & Grease	ppm	50	<=5
5.	Coliform	MPN /1000ml	10^6-10^7	<=100 MPN/100ml
6.	Suspended Solids	ppm	400	<=5

12.4 Control Philosophy

The operation and control philosophy of sewage water Treatment Plant shall be done through Relay based control system. Relay based control desk shall be provided with coloured Mimic, H.W. Annunciator, P.B., Indicators, indication Lamps and Ammeters.

TECHNICAL DATA SHEETS FOR SEWAGE TREATMENT PLANT

S. No.	Description	Units	Parameter
1.0	**Common Collection Sump**		
i)	Numbers Required	Nos.	One
ii)	Capacity	M3	2.0
iii)	MOC:		RCC
1.01	**Common Collection Sump Pumps**		
i)	Numbers Required	Nos.	2
ii)	Type		Non clog sump Pumps
ii)	Flow	M3/hr	2
iii)	Head	MWC	As per process requirements
iv)	Particle Size		Upto 20 mm
v)	MOC		CI-Casing, Impeller-SS-316, Shaft: SS-316
1.02.	**Screen Chamber**		
i)	Numbers Required	Nos.	1(1w+0s)
ii)	Type		Perforated Sheet
ii)	Cleaning		Manual
iii)	Angle of inclination		60
iv)	Bar MOC		SS-304 fitted with MS frame
v)	Velocity	m/s	<1.0
vi)	Spacing of Bar	mm	10
1.03	**Oil & Grease Trap**		
i)	Numbers Required	Nos.	One
ii)	Flow	M3/hr	2
iii)	MOC:		RCC with baffle arrangements
1.04	**Equalization Tank**		
i)	Numbers Required	Nos.	1
ii)	Flow	M3/hr	2.0
iii)	Detention Time	Hrs	4
iv)	MOC of Tank		RCC
v)	Depth	M	2.5-4.0
vi)	Type of Aeration		Coarse Bubble Diffused Aeration Type
vii)	Type of Diffusers		Coarse bubble diffusers with retrievable arrangement
viii)	No. of Diffusers		As per requirement
1.05	**Air Blowers for Equalization Tank/ Sludge Sump**		
i)	Numbers Required	Nos.	2
ii)	Type of Blower		Twin lobe
iii)	Flow	M3/hr	To cater Air requirement for Equalization tank & Sludge Sump.
iv)	Head	Mtrs	As per process requirements
iv)	MOC		CI
v)	Accessories		NRV, Pressure Guage,Safety

S. No.	Description	Units	Parameter
			valves, Silencer., PRV, Filter, etc.
1.06	**FAB Feed Pumps**		
i)	Numbers Required	Nos.	2
ii)	Type		Vertical Submersible Pumps
ii)	Flow	M3/hr	2
iii)	Head	MWC	As per process requirements
iv)	MOC		CI
v)	Particle Size		Upto 20 mm
1.07	**FAB Reactor**		
i)	Numbers Required	Nos.	1
ii)	Flow	M3/hr	2.0
iii)	F/M Ratio	Kg BOD/ kg/ MLSS	0.1-0.15
iv)	MLSS	mg/l	3000-6000
iv)	MOC of Tank		MSRL
v)	Depth	M	Min 4-5 Mtrs
vi)	Type of Aeration		Fine Bubble diffused Aeration Type
vii)	Type of Diffusers		Silicon based fine bubble diffusers retrievable arrangement
viii)	No. of Diffusers		As per requirement
ix)	Fab Media		PVC
x)	Media Qty		As per requirement
xi)	Free Board	mm	500
xii)	Volume	M3	As per Process Requirements
1.08	**Air Blowers for FAB Tank**		
i)	Numbers Required	Nos.	2
ii)	Type of Blower		Twin lobe
iii)	Flow	M3/hr	To cater Air requirement for Aeration Tank.
iv)	Head	Mtrs	As per Process Requirements
v)	MOC		CI
vi)	Accessories		NRV, Pressure Guage,Safety valves Silencer., PRV, Filter, etc.
1.09	**Tube Settler /Secondary Settler**		
i)	Numbers Required	Nos.	1
ii)	Flow	M3/hr	2.0
iii)	Surface Flow Rate	M3/m2/hr	2
iii)	MOC of Settler		MSRL
iv)	Qty of Tube settler Media		As per Process Requirements
v)	MOC of Media		PVC
vi)	Free Board	mm	500
1.10	**Hypo Contact Cum Filter Feed Tank**		
i)	Numbers Required	Nos.	1
ii)	Capacity	M3	As per Process Requirements
iii)	MOC		PVC
iv)	Make		Sintex

S. No.	Description	Units	Parameter
1.11	**Hypo Dosing System**		
1.11.1	**Hypo Dosing Tank**		
i)	Quantity		05 Nos. (4 nos. for Septic Tanks & 1 no. for Hypo Contact Filter Feed tank)
ii)	Capacity		As per Process Requirements
iii)	MOC		MSRL
1.11.2	**Hypo Dosing Pumps**		
i)	Quantity		6 Nos. (4 nos. for Septic Tanks & 2 nos. for Hypo Contact Filter Feed tank)
ii)	Capacity		As per Process Requirements
iii)	Type		Metering
iv)	Make		Std.
1.12	**Filter Feed Pumps**	Nos.	Two (2X 100%)
i)	Type & Operation		Horizontal, Centrifugal, Continuous
ii)	Suction condition		Flooded.
iii)	Capacity & Head	M3/hr, MWC	Approx 2, as per process requirement
iv)	Material of Construction		
	• Casing		Cast Iron IS:210 Gr FG 260
	• Impeller		Stainless steel CF 8M
	• Shaft & Shaft sleeve material		Stainless steel SS Gr. 304 & SS316
	• Packing seal		Mechanical type
	• Drive motor		Induction motor, 415V, 3 Φ, 50 Hz, TEFC.
	• Common base plate		Carbon steel IS:2062
v)	Noise level		85 DBA
vi)	Vibration		As per HIS
vii)	RPM		1500
viii)	Drive motor		Induction Motor 415V, 3 Phase, 50 Hz, TEFC
ix)	Interconnecting Piping Material		Carbon Steel with Rubber lining.
1.13	**Dual Media Filter**		
i)	Quantity	Nos.	1
ii)	Capacity	M3/hr	2
iii)	Surface Flow Rate	$M3/hr/m^2$	10
iv)	Size		As per Process Requirements
v)			
vi)	MOC		Epoxy coated carbon steel
vii)	Media		Graded quartz sand free from carbonates and other foreign material and anthracite.
viii)	Rising Space		100%
ix)	Make		Standard

1.14	**Activated Carbon Filter**		
i)	Quantity	Nos.	1
ii)	Capacity	M3/hr	2
iii)	Surface Flow Rate	M3/hr/m2	15
iv)	Size		As per Process Requirements
v)			
vi)	Media		Activated Carbon
vii)	Supporting Media		Graded Gravel
viii)	Minimum Bed Depth	mm	1200
ix)	Rising Space		100%
x)	Shell & Dish Material		Epoxy coated carbon steel
1.15	**Treated Water Tank**		
i)	Numbers Required	Nos.	1
ii)	Flow	M3/hr	2
iii)	Detention Time	Hrs	8
iv)	MOC of Tank		RCC
v)	Depth	M	2.5-4.0
1.16	**Treated Water Pumps**	Nos.	Two (2) (1W+1S) 100%
i)	Type & Operation		Horizontal, Centrifugal, Continuous
ii)	Suction condition		Flooded.
iii)	Material of Construction		
iv)	Casing		Cast Iron IS:210 Gr FG 260
v)	Impeller		Stainless steel CF 8M
vi)	Shaft & Shaft sleeve material		Stainless steel SS Gr. 304 & SS316
vii)	Packing seal		Mechanical type
viii)	Drive motor		Induction motor, 415V, 3 Φ, 50 Hz, TEFC.
ix)	Common base plate		Carbon steel IS:2062
x)	Noise level		85 DBA
xi)	Vibration		As per HIS
xii)	RPM		1480
xiii)	Drive motor		Induction Motor 415V, 3 Phase, 50 Hz, TEFC
xiv)	Interconnecting Piping Material		Carbon Steel with Rubber lining.
1.17	**Sludge Sump (Waste Pit)**		
i)	Number	No.	One (1)
ii)	MOC & Type		RCC, Under ground, Outdoor location
iii)	Capacity	Cu.m	As per Process Requirements
iv)	Instruments		Level switch with indication on panel
v)	Inside Protection		5 mm thick coal tar epoxy screened lining
1.18	**Sludge Transfer Pumps**	Nos.	Two (2) (1W+1S) 100%
i)	Numbers Required	Nos.	2
ii)	Type		Horizontal Screw Pumps
iii)	Location		Outdoor

iv)	Type of Fluid		Sludge From clarifier
v)	Rated Flow	M3/hr	As per process requirements (approx 2)
vi)	Head		As per process requirements
vii)	Service		Intermittent
viii)	Pump Speed	RPM	1500
ix)	Material of Construction		
	• Casing		2% Ni.- CI to IS 210 FG 260
	• Rotor		SS-316
	• Stator		Nitrile/EPDM
	• Shaft		SS-316
1.19	**Centrifuge**	Nos.	One(1)
i)	Type		Decanter
ii)	Inlet Concentration		2%
iii)	Outlet Concentration		20%(Min.)
iv)	Capacity		As per Process Requirements
v)	Liquid Handled		Secondary Sludge
vi)	Material of Construction		Wetted Parts-SS-304 Other parts – MSEP/CI
vii)	Motor		IP55 with outdoor installation, 3 phase, 415V, TEFC Type Squirrel cage induction Motor,Rating as per requirement.
viii)	Base Frame		MS Fabricated
ix)	Acessories		Suitable piping, valves pressure guage at delivery Pulley, V Belt Drive , foundation Bolts etc.
1.20	**PE Dosing System**		
i)	**Dosing Tank**	Nos.	1
ii)	Capacity of Tank	lts	100
iii)	MOC Of Tank		PVC
iv)	**Dosing Pumps**	Nos.	2
v)	Dosing Pump Capacity	lph	0-6
vi)	Type		Metering
vii)	MOC		

Chapter 27: LP PIPING, VALVES & SPECIALITIES

27.0 LP PIPING, VALVES & SPECIALITIES

27.1 Equipment sizing Criteria

27.1.1 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.

27.1.2 For all LP piping system covered under this specification, sizing and system design shall be to the requirements of relevant codes and standard indicated elsewhere. In addition to this, requirements of any statutory code as applicable shall also be taken into consideration.

27.1.3 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

		Water Velocity in m/sec		
	Pipe Size	**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

The pipes in CW, ACW & DMCW system shall be designed to maintain a maximum velocity of 2 m/s inside the pipelines at pump discharge.

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)	CI Pipe/Ductile Iron	100
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)

27.1.4 The pipes shall be sized for the worst (i.e. maximum flow, temp. and pressure values) operating conditions.

27.1.5 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.

27.1.6 Corrosion allowance of 1.6 mm will be added to the calculated thickness being considered.

27.1.7 Bend thinning allowance/manufacturing allowance etc. shall be as per the requirement of the design code provision.

27.1.8 High points in piping system shall be provided with vents alongwith valves as per the system requirement. Low points shall be provided with drains alongwith 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.

27.1.9 Material of construction for pipes carrying various fluids shall be as specified elsewhere.

27.1.10 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.

27.1.11 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.

27.1.12 Threaded joints shall be provided with Teflon sealant tapes.

27.1.13 Following types of valves shall be used for the system/service indicated.

System	Type 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		x	x	x	x	x

In water service, valves above 200 NB size may be butterfly valves.

27.1.14 Recirculation pipes alongwith 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.

27.1.15 All Piping 450 NB & Above shall be designated as Large dia Piping.

27.2.00 TECHNICAL SPECIFICATION

27.1.00 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.

27.2.00 Pipes and fittings

27.2.1 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 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.

27.2.2 Piping and fittings coming under the purview of IBR shall be designed satisfying the requirements of IBR as a minimum.

27.2.3 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.

27.2.4 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).

27.2.5 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.

27.2.6 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.

27.2.7 For rubber lined ERW pipes, beads shall be removed.

27.2.8 Inspection holes shall be provided at suitable locations for pipes 800 NB and above as required for periodic observations and inspection purposes.

27.2.9 At all intersection joints, it is Contractor's responsibility to design and provide suitable reinforcements as per the applicable codes and standards.

27.2.10 For large size pipes/duct, 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 wherever 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 such as CW/ ACW/ Raw Water etc.

27.3.00 Material

27.3.1 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.

27.3.2 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.

27.3.3 All materials shall be new and procured directly from the manufacturers. Materials procured from traders or stockiest are not acceptable.

27.3.4 All materials shall be certified by proper material test certificates. All material test certificates shall carry proper heat number or other acceptable reference to enable identification of the certificate that certifies the material.

27.3.5 Material of construction for pipes carrying various fluids shall be as follows:

1	Intake Water, Raw water, Ash water, Circulating Water (CW), Aux. Cooling water (ACW), clarified Water, CW blow down, *Effluent disposal, service water, AHP Seal Water, Air Pre-Heater Wash water, Passivated DM Water and clarifier sludge.	IS-2062 Gr. B/ASTM-A-36/ASTM A-53 type 'E' Gr. B/IS-3589 Gr. 410/IS-1239 Heavy. Buried CW pipes shall be encased in 500 mm thk RCC. At road crossings live loads should be considered and this encasing thickness shall vary accordingly. 150 NB & above pipes shall be spiral welded.

2	Dematerialized water, (condenser Make up water, Boiler fill and Deaerator Fill water) & DMCW overhead tank make-up water	Stainless steel to ASTM A-312, Gr. 304 welded for sizes above 50mm NB Stainless steel to ASTM A312, Gr. 304 sch. 40 Seamless for sizes 50 mm and below
3.	*Drinking (potable) water	ASTM A-53 type E Gr. B galvanized /IS 1239 heavy galvanized/IS 3589 Gr 410 Galvanized to IS-4736 or equivalent.
4.	Instrument air & plant air.	ASTM A-53 type E Gr. B galvanized /IS 1239 heavy galvanized/IS 3589 Gr 410 Galvanized to IS-4736 or equivalent.
5.	Fuel Oil piping	API5L

NOTE: Bidder to note that for Effluent disposal system and potable water system for colony (* marked) Ductile Iron (DI) pipes conforming to IS 8329 and for fittings IS 9523 can be offered as an alternate to the mild steel/ galvanized mild steel pipes as specified above for standalone or outside plant boundary stretches. Various design aspects of DI piping has been discussed later in Annexure-I.

27.3.6 In water lines, pipes upto 150 mm 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.

27.3.7 Pipes of above 150 mm 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. B/ASTM-A-36. However, larger pipes, i.e. 1000 mm NB and above shall be made from plates conforming to ASTM A 36/IS 2062 Gr. B 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).

27.3.8 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 65 mm 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.

27.3.9 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).

27.3.10 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.

27.3.11 Condensate lines shall be to ASTM A 106 Gr. B and dimension to ANSI B 36.10 schedule "standard'' as minimum to be maintained.

27.3.12 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.

27.3.13 Buried CW Pipes/ headers shall be minimum 12 mm thick, encased in 500 mm thk RCC. However this thickness shall be reviewed for live loads at road crossings according to AWWA M11 and increased adequately, if required.

27.4.0 Piping Wall Thickness

27.4.1 The calculation of wall thickness required for pipelines subject to internal and/or external pressure shall be based on the formulae and recommendations as given in the applicable codes. Adequate allowances shall be made towards thinning due to bending, weakening at branch connections, threading, commercial tolerances on pipe wall thickness, corrosion and erosion, etc., and the same shall be subject to approval by Purchaser. In any case a minimum corrosion allowance of 1.6 mm shall be considered while selecting the thickness.

27.4.2 In case of carbon steel materials, the nominal wall thickness of pipeline shall not be less than the minimum acceptable values given below:

NB mm (inch)	15 (1/2)	30 (3/4)	25 (1)	32 (1¼)	40 (1.5)	50 (2)	65 (2.5)	80 (3)	100 (4)	125 (5)
Min. thickness, mm	3.2	3.2	3.6	3.6	3.6	3.6	3.6	4.0	4.5	5.4
NB mm (inch)	150 (6)	200 (8)	250 (10)	300 (12)	350 (14)	400 (16)	450 (18)	500 (20)	600 (24)	
Min. thickness, mm	5.4	6.35	6.35	6.35	7.1	7.1	7.1	8.0	8.0	

> NB 600 mm to NB 900 mm	-	8.0 mm
> NB 900 mm to NB 1200 mm	-	10.0 mm
> NB 1200 mm to 1400 mm	-	12.0 mm
> NB 1400 mm to 1600 mm	-	14.0 mm
> NB 1600 mm to NB 2200 mm	-	16.0 mm
> NB 2200 mm	-	18.0 mm

NOTE: For buried CW pipe with 500 mm thick RCC encasing (as detailed in cl. no. 27.3.5), the minimum acceptable thickness shall be as indicated below.

> NB 600 mm to NB 900 mm	-	8.0 mm
> NB 900 mm to NB 1200 mm	-	10.0 mm
> NB 1200 mm	-	12.0 mm

27.5.00 Piping Layout

27.5.1 Piping shall be grouped together where practicable and routed to present a neat appearance.

27.5.2 Piping routing shall be such as to provide sufficient clearance for removal and maintenance of equipment, easy access to valves, instruments and other accessories. The piping shall not encroach on the withdrawal space of various equipments.

27.5.3 Over head piping shall have a normal minimum vertical clearance of 2.5 meters above walkways and working areas and 8 m above roadways/railways. When several pipelines are laid parallel, flanged joints must be staggered. Welded and flanged joints should as far as possible be located at one third span from supports. If the support is situated right under the welded joints this joint must be reinforced with a strap. Flanged and welded joints must be avoided in the middle of the span. Valves should be located in such a manner so as to ensure their convenient operation from the floor or the nearest platform.

27.5.4 Pipelines 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-pipe and submit to Employer for approval.

27.5.5 All piping shall be routed so as to avoid interference with other pipes and their hangers and supports, electrical cable trays, ventilation ducting, structural members, equipment etc.

27.5.6 Adequate clearance shall be ensured with respect to the above to accommodate insulation and pipe movements, if any.

27.5.7 Piping shall generally be routed above ground but where specifically indicated / approved by the project Manager the pipes may be arranged in trenches or buried. Pipes at working temperature above the ambient shall however not be buried.

27.5.8 Sufficient up stream and down stream lengths shall be provided for flow measuring devices, control valves and other specialties.

27.5.9 All local instruments shall be located on pipelines as to render them observable from the nearest available platforms.

27.5.10 Openings provided in the wall for pipelines must be closed with bricks and mortar with 10-12 mm clearance between brick work and pipe after taking care of insulation and thermal movement, if any. The clear space must be filled with felt or asbestos or approved filling compound.

27.6.00 Slope / Drains and Vents

27.6.1 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 shall not be less than 15 mm 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 15 mm for line size up to 150 mm, not less than 20 mm up to 300 mm and not less than 25 mm for 350 mm to 600 mm pipes and not less than 50 mm for 600 mm and above pipes.

27.6.2 Air piping shall be sloped so that any part of the system can be drained through the shut-off drain valve or drain plugs.

27.7.0 Pipe Joints

In general all water lines 65 mm 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 50 mm and below by socket welding unless mentioned otherwise specifically. All air lines shall be of screwed connection and rubber lined pipes of flanged connections.

27.7.1 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 joined by welding. 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 an 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, alongwith the nascent threaded metal portion 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 pasts. 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.

27.7.2 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.

27.7.3 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.

27.8.00 Bends/elbows/mitre bends/Tees/Reducers & other fittings

27.8.1 Unless otherwise specified elbows shall be of long radius type.

27.8.2 For pipe sizes up to 65 Nb, long radius forged elbows or seamless pipe bends shall be used. Pipe bends, if used, shall be cold bent to a radius measured to the centre line of pipe of 3 to 5 times the pipe diameter.

27.8.3 For steel pipes 80 Nb and above, seamless long radius forged elbows shall be used. For pipe size 250 Nb 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.

27.8.4 Mitre bends are not acceptable in case of rubber lined mild steel pipes.

27.8.5 For pipe fittings such as reducers an tees, the material shall be to astm-a-234 gr. WPB up to 300 NB. For pipe reducers and tees 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 fittings shall conform to the dimensional standard of ANSI B-16.9.

However, for pipes upto 150 NB, pipe fittings may be supplied with material and dimension conforming to IS 1239 in case parent pipes also conform to IS 1239.

For pipes, above 1200 NB, reducer and tees shall be to dimensional standard of AWWA-C-208.

27.8.6 Stainless steel fittings shall conform to either ASTM-A-182, Gr. 304 (316 for Sea water application, if any) or ASTM-A-403, Gr. WP 304 (316 for Sea Water application, if any) Class-S, for sizes upto and including 50 mm NB, i.e. the fitting shall be of seamless construction.

However, for stainless steel fittings above 50mm NB, the same shall conform to ASTM-A-403, Gr. WP 304 (316 for Sea water application, if any), Class W i.e. the fittings shall be of welded construction strictly in accordance with ASTM-A-403.

27.8.7 In no case, the thickness of fittings shall be less than the thickness of parent pipe, irrespective of material of construction.

27.9.00 Flanges

27.9.1 Flanges shall be slip on type. Welding of flanges in tension is not permitted.

27.9.2 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. B. However stainless steel flanges shall be fabricated from SS plates to ASTM-A-240, Gr. 304 (316 for Sea water application, if any) or equivalent.

27.10.00 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.

27.10.1 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.

(b) Free access shall be provided for the welding of the circumferential joints by increasing the width and depth of the trench at these points. There should be no obstruction to the welder from any side so that good welded joint is obtained.

(c) The free working space shall conform to IS: 5822. The trench shall be excavated so as to provide minimum cover of 1000 mm between the top of the pipe and finished grade.

(d) Prior to lowering and laying pipe in any trench, the bidder shall backfill and compact the bottom of the trench or excavation in accordance with IS: 5822 to provide an acceptable bed for placing the pipe.

(e) Coating and Wrapping shall be done as under.

27.10.2 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 blasting, power tool cleaning, etc. Grease or heavy oil shall be removed by washing with a volatile solvent such as gasoline. Kerosene will not be permitted for cleaning. This cleaning operation shall be immediately followed by priming with the mechanical priming machine.

(b) 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.

(c) 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.

(d) The cleaning and priming operation shall be carried out at site. The entire pipe length shall be cleaned but the ends of the pipes shall be left without coating for a distance of 230 mm for joints, which shall be coating manually at site after laying, welding and testing the pipe.

27.10.3 **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 2 mm 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 min.

27.10.4 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.

27.10.5 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 joints 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.

27.11.00 Cleaning and Flushing

27.11.1 All piping shall be cleaned by the Bidder before and after erection to remove grease, dirt, dust, scale and welding slag.

27.11.2 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. The brushes shall be of the same or similar material as the metal being cleaned. Cleaning of Galvanized pipes shall be done in such a manner that the coating on MS pipe is not affected.

27.11.3 After erection, all water lines shall be hydro tested at 1.5 times the design pressure.

27.11.4 All compressed air pipe work shall be cleaned by blowing compressed air.

27.12.00 Painting of Pipes

27.12.1 Buried Piping

Internal surfaces

(i) Surface cleaning by sand blasting.

(ii) Two (2) coats of epoxy primer coats. The minimum DFT of each coat shall be 35 microns.

(iii) Finish coat-Two (2) coats of high build epoxy paint. The minimum DFT of each coat shall be 35 microns.

The total dry film thickness of 150 microns.

Tests to be carried out after application : Bond/ Adhesion test, Holiday test

External surfaces

(i) Surface cleaning by Sand Blasting.
(ii) Coal tar primer compatible with coal tar enamel grade. The number of coats shall be two with a DFT of 35 microns each.

(iii) Coal tar enamel shall be applied. A single spiral inner wrap of glass fibre tissues shall be applied overlapping at least 25 mm ensuring impregnation of glass fibre tissues in the first coat. The second coat of enamel and second outer wrap of glass fibre felt, Type – I to IS: 7193-1974 will be applied in the same way confirming to Table – 10 of IS – 10221 – 1982.

The total thickness of the coating will not be less than 4.0 mm

(iv) Alternatively Wrapping with coal tar based anticorrosion tape conforming to IS 15337: 2003 is also acceptable in lieu of s.no. (iii) above. Wrapping thickness shall be 4.0 mm.

NOTE : CW piping shall be encased in 500 mm thk RCC.

Tests to be carried out after application : Bond/ Adhesion test, Holiday test

27.12.2 Overground Piping

Internal surfaces

(i) Surface cleaning by sand blasting.

(ii) Two (2) coats of epoxy primer coats. The minimum DFT of each coat shall be 35 microns.

(iii) Finish coat-Two (2) coats of high build epoxy paint. The minimum DFT of each coat shall be 35 microns.

The total dry film thickness of 140 microns (min).

External surfaces

(i) Surface cleaning by Sand Blasting.

(ii) Two (2) coats of epoxy primer coats. The minimum DFT of each coat shall be 35 microns.

(iii) Finish coat-Two (2) coats of high build epoxy paint. The minimum DFT of each coat shall be 35 microns.

The total dry film thickness of 140 microns (min).

27.12.3 Other requirements

(a) Paint manufacturers instructions shall be followed in method of application, handling, drying time etc.

(b) The color of the finish paint shall be as per approved color-coding.

(c) If finish paint was applied in shop, one coat of finish paint shall be applied at site.

(d) The dry film thickness of paint shall not be less than 0.15 mm.

27.12.4 Color code for identification

The pipes shall be color painted/banded for identification as per the approved color-coding scheme and shall be generally as per IS-9404.

27.13.00 Specification for hangers and supports

27.13.1 All supports and parts shall conform to the requirement of power piping code ANSI B 31.1 or approved equivalent.

27.13.2 While designing supports for rubber lined pipes special consideration should be given. Any kind of welding on these pipes is not allowed after rubber lining.

27.13.3 Hanger for piping 65 mm Nb and larger and all spring support assemblies regardless of size shall be completely engineered in conformance with the provisions of power piping code ANSI B 31.1.

27.13.4 Hangers, saddles, supports etc. shall be fabricated from plates/pipes sections conforming to ASTM A 53/IS: 2062/IS:226/ or equivalent. They shall be designed to provide the required supporting effects and allow pipeline movements as necessary. The structural steel work shall be as per IS: 800/BS:4360. Insulation protection saddles shall be used at support point of all insulated piping.

27.13.5 The support shall be so interspaced as to minimize sagging of the pipes and to keep them with in permissible limits where pipes are full with the conveying media.

27.13.6 The maximum spans of the supports of straight length shall not exceed the recommended values indicated in ANSI B 31.1.

27.13.7 All pipe supports shall be designed to provide an absolute minimum head room of 2.5 m from floor in passages/walkways.

27.13.8 At all sliding surfaces of supports suitable arrangement is to be provided to minimize sliding friction.

27.13.9 All components of hangers/support shall be provided with two coats of primer (red oxide paint) at shop before dispatch to site. After erection they shall be given finish coat of Long Oil Synthetic enamel to IS: 2932 of total DFT 100 to 140 microns. CLH & VLH will be primed with Epoxy Zinc rich primer of 50 micron followed by finish painting of Aliphatic Acrylic Polyurethane or equivalent of DFT 65 microns.

27.14.00 Design/Construction/Material Particulars of Gate/Globe/Check Valves/Globe Stop Valve/Butterfly Valve

27.14.1 GENERAL

(a) All valves shall be suitable for the service conditions i.e. flow, temperature and pressure, at which they are required to operate.

(b) General requirement of valves are as indicated below:

(1) The valves as well as all accessories shall be designed for easy disassembly and maintenance.

(2) Valves to be installed outside shall be required to have the stem properly protected against atmospheric corrosion.

(3) All rising stem valves shall be provided with back seat to permit repacking (of glands) with valves in operation. All valves shall preferably be of outside screw and yoke type.

(4) All valves shall be closed by rotating the hand wheel in the clockwise direction when looking at the face of the hand wheel. In case where the hand wheel is not directly attached to the valve spindle suitable gearing shall be introduced.

(5) All valves shall have indicators or direction clearly marked on the hand-wheel so that the valves opening/closing can be readily determined.

(6) 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. For valves of size 350 mm and above either bevel or spur gearing shall be provided to facilitate manual operation.

(7) The valves coming in vacuum lines shall be of extended gland type and / or water sealed.

(c) 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.

(d) Valves coming under the purview of IBR shall meet IBR requirements.

(e) Gate/sluice valves shall be used for isolation of flow. 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.

(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 600 mm NB.

(h) All gate and globe valves shall be provided with back seating arrangement to enable on line changing of gland packing.

(i) 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.

(j) All valves shall be provided with embossed name plate giving details such as tag number, type, size etc.

(k) 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.

(l) All valves except those with rising stems shall be provided with continuous mechanical position indicator; 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.

27.14.2 VALVE BODY MATERIAL

Valve body material for various services shall be as follows:

Valve body material for water application like circulating water, 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 shall be cast iron for sizes 65 NB 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 alongwith SS internals.

Condensate: Cast Carbon Steel/Forged Carbon Steel.

27.14.2.1 The design, material, construction, manufacture, inspection, testing and performance of valves shall comply with all currently applicable statutes, regulations and safety codes and 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

27.14.2.2 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)

27.14.2.3 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).

27.14.2.4 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.

27.14.2.5 All gun metal body valves shall have screwed ends.

27.14.2.6 All flanged end valves/specialties shall be furnished alongwith matching counter flanges, fasteners, gaskets etc. as required to complete the joints

27.15.00 Check Valves

27.15.1 Check valves shall comply with the following characteristics:

(a) 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);
(b) For bore smaller than or equal to 2" the valves must be of the piston type to be installed, in horizontal position.

(c) In the case of swing check valves, the body seat shall be inclined at such an angle from the vertical as will facilitate closing and prevent chatter.

27.15.2 Drilling on flanges of flanged valves must correspond to the drilling on flanges of the piping system on which the valves are to be installed.

27.15.3 All flanged valves intended for installation in steel piping systems shall have their flanges drilled to ANSI B 16.5 (or equivalent) and according to the pressure class.

27.15.4 Counter flanges to be installed on air pipes shall be screwed-on type irrespective of size.

27.16.00 Globe Valves

27.16.1 The globe valves shall have the following characteristics;

Straight conveyed flow

Right angle

Preferably, the valves shall be of the vertical stem type.

27.16.2 Globe valves shall preferably have radiused or spherical seating and discs shall be free to revolve on the spindle.

27.16.3 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.

27.16.4 For the regulating valves, valves with regulating plug & parabolic outline disc type is preferred.

27.16.5 All motorized globe valves with regulating plug for which indication of percentage (%) opening are required in the control room shall be provided with necessary position transmitter.

27.17.00 Gate valves

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 and rising stem type.

27.18.00 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 devise within them. Each Air release valve shall be mounted, preceded by a separate isolation gate/butterfly valve.

125# ASA cast iron body, double ball construction air release valve with flanged ends to ASA B 16.10; and bolted cover to release the air. Construction materials shall be as below:

Body, cover	:	Cast iron to IS:210 Gr.FG 260
Bolts	:	Light weight leather/wooden balls
Seats	:	Bronze to ASTM-B-62
Cover packing	:	Braided asbestos
Float	:	Wood/rubber

27.19.00 Butterfly Valves

27.19.1 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. B) butterfly valves instead of cast iron body valves are also acceptable for size above 300 mm nb diameter. In such a case, however, the bidder will have to necessarily submit thickness calculations, in order to establish the integrity of the fabricated valve body under the system operating pressure condition.

(1) 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.

(2) The seals, both on the body (sleeve) and on the disc shall be of the material specified. Necessary shaft seal shall be provided and adequately designed to ensure no leakage across the seal. This seal shall be designed so that they will allow replacement without removal of the valve shaft. The sealing ring on the disk shall be continuous type and easily replaceable.

(3) For all types of valves, the design with shaft eccentric to the disc is preferred. The shaft shall be solid type and shall pivot on bushings. Bushings/sleeve type bearings shall be contained in the hub of valve body. The bearing shall be self-lubricated type with low coefficient of friction and should not have any harmful effect on water and on valve components.

(4) The design of the shaft shall be such that it will safely sustain maximum differential pressure across the closed valve. The shaft and any key (taper pin etc.) for transmitting the torque between shaft and disc shall be capable of withstanding the maximum torque required to operate the valve. However, the shaft diameter shall not be less than the minimum shaft diameter specified in relevant code. Necessary Torque Calculation and the torque class selected on the basis of the same shall be furnished to the Employer for information.

(5) The disc shall rotate from the full open to the tight shut position. The disc shall be contoured to ensure the least possible resistance to flow and shall be suitable for throttling operation. While the disc is in the throttled position, valve shall not create any noise or vibration.

(6) The operating mechanism shall be mounted directly on or supported from the valve body.

(7) All valves shall be complete with:

Position indicator (located in a visible place)

Arrow indicating the flow direction;

Adjustable mechanical stop limiting devices to prevent over

Travel of valve disc in open/close position.

All valves shall be "tight shut off''

(8) Hand operated valves shall have the following

Local hand controls

The hand controls shall close the valve with clockwise rotation.

The hand controls shall be dimensioned to guarantee an easy maneuver under most severe conditions.

The hand controls shall be provided with locking systems suitable to avoid the disc assuming a non-desirable position during the operation.

Hand wheel shall be made of malleable iron with arms and rims of adequate strength. The hand wheel of diameters 300 mm or less shall be provided with handles for ease of operation. The pulling force required on the hand wheel rim shall not exceed 25 Kgf when operating the valve under full flow and operating pressure.

Valves-350 Nb and above shall have pressure equalizing bypass valves, wherever system parameters warrant the same.

Valves-350 Nb and above shall also be provided with gear operator arrangement suitable for manual operation. Manual operation of valve shall be through worm and 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 alongwith suitable space heaters for motor actuated valves, which may be either for On-Off operation or inching operation with position transmitter.

27.19.2 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 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	ASTM A 351, Gr. CF8M/ASTM-A-182-Gr. 304
Shaft	ASTM A 182, Gr. 316/ASTM-A-479 Gr. 316/Equivalent
Disc & Seat Rings	EPT/BUNA-N/Neoprene

(c) Carbon Steel Butterfly Valves

Body & Disc	ASTM A 216, Gr. WCB
Shaft	ASTM A 182, Gr. 304/ASTM-A-479 Gr. 304/Equivalent
Disc & Seat Rings	EPT/BUNA-N/Neoprene

27.19.3 Proof of Design Test (Type Test) for Butterfly Valves

Proof of Design (POD) 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 POD test shall be conducted by the bidder in the presence of Employer's representative.

All valves that are designed and manufactured as per AWWA-C-504 shall be governed by the relevant clauses of POD test in AWWA-C-504. For Butterfly valves designed and manufactured to EN-593 or equivalent, the POD test methods and procedures shaft 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 POD test of AWWA-C-504.

27.20.00 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	ASTM A 351 Gr. CF 8M/

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	ASTM A 182 Gr. 304
Disc	-do-
Trim.	ASTM 182 Gr. F. 316 /ASTM-A-479 Gr. 316 or Integral with body

(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.

27.21.00 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.

27.22.00 PAINTING OF VALVES:

Two (2) coats of primer followed by three (3) coats of epoxy of approved color code/shade (usually same as that of connected piping) shall be applied to all exposed surfaces except stainless steel surface, Galvanized steel surface and gun metal surface at shop as required to prevent corrosion, before dispatch. The use of grease/oil other than light grade mineral oil, for corrosion protection is prohibited. The total DFT of paining shall be 150 micron (minimum). If during transport, unloading/unpacking or erection at site any part of the painted surface gets damaged, the same shall be made good by the contractor by repainting with compatible painting primer and enamel to the satisfaction of the project manager.

27.23.00 RUBBER EXPANSION JOINTS

27.23.1 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.

27.23.2 The expansion joints shall be single bellow rubber expansion joints. The arches of the expansion joints shall be filled with soft rubber.

27.23.3 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.

27.23.4 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.

27.23.5 Reinforcement, consisting of solid metal rings embedded in carcass shall be provided.

27.23.6 Expansion joints shall be complete with stretcher bolt assembly. The expansion joints shall be suitable to absorb piping movements and accommodate mismatch between pipelines.

27.23.7 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.

27.23.8 The expansion joints shall be adequately reinforced, with solid steel rings, to meet the service conditions under which they are to operate.

27.23.9 All expansion joints shall be provided with stainless steel retaining rings for DM water application and IS 2062 Gr. B 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.

27.23.10 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.

27.23.11 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.

27.23.12 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.

27.23.13 Each joint shall have a permanently attached brass or stainless steel metal tag indicating the tag numbers and other salient design features.

27.23.14 Bidder to note that any metallic part which comes in contact with DM / Corrosive water shall be of stainless steel material.

27.24.00 STRAINERS

27.24.1 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 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

27.24.2 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 of ASTM-A-515 Gr. 75/IS-2062 Gr. B and internally epoxy-painted above 50 mm NB.
Strainer element	Stainless steel (AISI 316)
End connection	Screwed up to 50 mm 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.

27.24.3 Three shop coats of paint preceded by two coats of primer shall be applied to all exposed surfaces as required to prevent corrosion. All parts shall be adequately protected for rust prevention. The use of grease or oil other than light grade mineral oils for corrosion protection is prohibited

ANNEXURE-I

SPECIFICATION FOR DUCTILE IRON (DI) PIPES, FITTINGS & SPECIALS

1.00.00 GENERAL

This specification covers the specific requirement of design, material, manufacture / fabrication, constructional features, inspection & testing, transportation, handling, laying, site testing and annual maintenance contract of Ductile Iron (DI) Pipes, Joints, fittings and specials.

2.00.00 CODES AND STANDARDS

The material, design, manufacture, dimensions, tolerances, mechanical properties, internal cement mortar lining, external zinc coating along with bituminous finished layer, inspection and testing of DI water pipes shall comply with the latest Indian Standard, "IS 8329 (Centrifugally cast (spun) ductile iron pressure pipes for water, gas and sewage – specification)" or equivalent international standard unless otherwise specified elsewhere in this Technical Specification.

Sl. No.	Code No.	Code Title
1	IS 8329	Centrifugally cast (spun) ductile iron pressure for water, gas and sewage - specification
2	IS 9523	Ductile iron fittings for pressure pipes for water, gas and sewage - specification
3	IS 5382	Rubber sealing rings for gas mains, water mains and sewers
4	IS 638	Specification for Sheet Rubber Jointing and Rubber Insertion Jointing
5	IS 12288	Code of practice for use and laying of Ductile Iron pipes
6	IS 11606	Methods of sampling of Cast Iron pipes and fittings
7	IS 455	Portland slag cement
8	IS 12330	Sulphate resisting Portland cement
9	IS 6452	Specification for high alumina cement for structural use
10	IS 6909	Specification for supersulphated cement
11	IS 8112	43 grade ordinary Portland cement
12	IS 1387	General requirements for supply of metallurgical materials
13	IS 1500	Methods for Brinell hardness test for metallic materials
14	IS 1608	Mechanical testing of metals – tensile testing
15	ISO 2531	Ductile iron pipes, fittings,accessories and their joints for water applications
16	ISO 4179	Ductile iron pipes and fittings for pressure and non-pressure pipelines – Cement mortar lining
17	ISO 4633	Rubber seals – Joint rings for water supply, drainage and sewerage pipelines – Specification for materials

18	ISO 8179	Ductile iron pipes – External zinc-based coating – Part 1: Metallic zinc with finishing layer
19	ISO 8179	Ductile iron pipes – External zinc coating – Part 2:Zinc rich paint with finishing layer
20	ISO 8180	Ductile iron pipelines – Polyethylene sleeving for site application
21	ISO 10802	Ductile iron pipelines – Hydrostatic testing after installation
22	ISO 10803	Design method for ductile iron pipes
23	ISO 16132	Ductile iron pipe and fittings – seal coats for cement mortar linings
24	AWWA M 41	Ductile iron pipe and fittings (guideline code for design, manufacturing, testing, jointing, laying& installation etc.)
25	BS EN 545	Ductile iron pipes, fittings,accessories and their joints for water pipelines – Requirements and test methods

3.00.0 DUCTILE IRON (DI) PRESSURE PIPES:

3.01.01 DESIGN REQUIREMENTS

Pipeline shall be sized considering C value as 140 and velocity 2-3m/sec.

3.01.01 Classification:

The class of DI pipes to be provided shall be as specified in the data sheet attached with this sub-section. The external diameter and wall thickness of socket and spigot pipes for the specified Class shall be as per IS 8329 or equivalent international standard.

3.02.00 Joints:

3.02.01 Generally push-on flexible joints shall be provided for pipe to pipe connection as per IS 8329 or equivalent international standard. However mechanical joints, flange joints and restrained joints can also be used.

3.02.02 Rubber gaskets

Rubber gasket used with push-on flexible joints shall conform to the requirements of IS: 5382 or equivalent international standard. Rubber gaskets for use with flanged joints shall conform to IS 638 or approved equivalent international standard.

4.00.00DI FITTINGS & SPECIALS

4.01.0 Design Requirements

4.01.01 Classification

The DI fittings shall be as per IS 9523 or equivalent international standard.

4.02.00 External layer:

The DI fittings supplied shall be provided with external protection of metallic zinc coating or zinc rich paint coating with finishing layer of bituminous paint as per IS 9523 or equivalent international standard.

4.03.00 Internal lining:

The fittings shall be provided with suitable cement mortar internal lining as per IS 9523 or equivalent international standard.

4.04.00 Joints between pipe and fittings:

4.04.01 Generally , Push-on flexible joints shall be provided for pipe to fitting connection as per IS 9523 or equivalent international standard. Flange joints, wherever required, shall conform to the requirements of IS 9523 or equivalent international standard.

4.04.02 Rubber gaskets

All the DI fittings shall be provided with rubber gaskets for each socket. Rubber gasket used with push-on flexible joints shall conform to the requirements of IS: 5382/ IS 9523 or equivalent international standard.

Rubber gaskets for use with flanged joints shall conform to IS 638 or equivalent international standard.

5.00.00 TYPE TESTS

5.01.00 The contractor / manufacturer shall carry out the type tests as listed in this specification on the pipes to be supplied under this contract.

5.02.00 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.

5.03.00 In case the contractor / manufacturer has already conducted such specified type test(s), he may submit the type test reports to the Employer during detailed engineering for consideration of waiver of conductance of such type test(s) or otherwise as deemed fit by Employer. Such test(s) should have been either conducted at an independent laboratory or duly approved by accredited third party agency. The Employer reserves the right to waive conducting of any or all the specified type test(s) under this contract.

5.04.00 The type test shall be performed whenever a significant change is made in the design, material or process of manufacture or a new size or size range of the product is being supplied by the manufacturer.

5.05.00 THE FOLLOWING TYPE TESTS SHALL BE CARRIED OUT:

5.05.01 Joint Leak Tightness Test:

a) Tests for joints (push-on flexible joints) shall be conducted as per the guidelines of ISO 2531 to establish adequate joint performance with respect to internal pressure, external pressure and vacuum pressure under both normal alignment of joints and deflected alignment of joints as dictated in ISO 2531.

b) Tests for Leak tightness and mechanical resistance of flanged joints shall be conducted as per ISO 2531.

5.05.02 Cement Lining Smoothness Type Test:

The contractor / manufacturer should have carried out Cement Lining Smoothness test to establish C value (Hazen & William's constant) of the offered DI pipe as 140. Necessary certificate for the same shall be furnished to the employer.

In case the contractor / manufacturer has not carried out the test, the same shall be carried out by the contractor / manufacturer within the scope of this contract.

5.05.03 Ring bend test:

Ring bend test for 3% deflection with respect to external diameter of DI pipe offered shall be conducted by contractor / manufacturer to prove that internal cement mortar lining does not come off the substrate surface of Ductile Iron on random basis for each manufacturing lot.

If the contractor / manufacturer of pipes do not have the facility for this type test at his own works, the same can be arranged by him to conduct and demonstrate the test.

6.00.00 LAYING AND JOINTING OF DI PIPES:

6.01.00 Laying, erection and jointing of DI pipelines at field / site shall be under the direct supervision of Manufacturer (Supplier) from whom pipe is sourced / procured.
For underground laying, Special provisions in trench shall be made for accommodating socket (Bell) of each pipe, as applicable so that barrel is uniformly rested on even trench bed surface, which is well compacted as recommended in codes / standards.

6.02.00 Pipeline anchorage

Pipeline shall be securely anchored at dead ends, tees, bends, tapers and valves to resist thrust arising from internal pressure. Suitable thrust blocks made of concrete shall be designed and cast-in-situ.

7.00.00 HYDRAULIC TESTING OF PIPELINES

After laying and jointing, the pipeline shall be tested for soundness and leak tightness of pipes, fittings and joints, and soundness of any construction work. The pipeline may be tested in sections.

Water and other facilities as required for such hydro testing shall be arranged by the Contractor.

7.01.00 Hydraulic Testing of Sections

The section under test shall be filled with water, taking care that all the air is displaced either through vents at the high points or by using a pig or a sphere. After filling, the pipeline shall be slightly pressurized for a period of time to achieve stable conditions.

The pipeline is then pressurized up to the full test pressure as per the relevant standard. The test pressure shall be maintained for a period of not less than 10 minutes to reveal any defects in the pipes, joints or anchorages. The test pressure shall be measured such as to ensure that the required test pressure is not exceeded at any point in the entire pipeline.

If the test is not satisfactory, the fault shall be found and rectified. Methods employed for finding faults shall be as per IS 12288.

7.02.00 Hydraulic Testing of Complete Pipeline

After all the sections have been joined together on completion of section testing, a test on the complete pipeline shall be carried out. This test shall be carried out at a pressure as specified in the data sheet attached with this sub-section. During the test, the pressure at any point in the pipeline shall not exceed the pressure as specified in the data sheet attached with this subsection.

8.00.00 DATA SHEET FOR DI PIPES, FITTINGS & SPECIALS

Sl.No.	Description	Units	Parameters
1	Pipe Material		Ductile Iron (DI) pipe internally cement mortar lined and externally coated with metallic zinc & finishing layer of bituminous paint.
2	Applicable standards		IS/ISO/AWWA/BS as listed in technical specification
3	Hazen & Wliiam's Constant		140
4	Pipe class		K7/K9 as per IS 8329 or equivalent international standard. Compatible with system pressure requirement.
5	Pipe Joint type		Push-on flexible joints as per IS 8329 / Flanged/ Restraint

6	Pipe Joint type at valves, pumps and other piping		Flange Joints as per IS 8329 & IS 9523
7	Welded-on Flange (as applicabe) pressure class		Compatible with system pressure requirement.
8	DI fittings class		Compatible with system pressure requirement.
9	DI fittings flange (as applicable) class		PN 25
10	Restrain mechanism at bends, specials etc.		Thrust Blocks
11	Maximum field hydrostatic test pressure	N/mm^2	Shut-off pressure or (opearating pressure+surge pressure) whichever is higher for not less than 10 minutes
	At each section (not exceeding 1000m)		
	Complete pipeline		As per IS: 12288 Table-1
12	Other requirements		As per technical specification

PAINTING

1.0 SCOPE

This section covers the painting requirements for the power plant equipment, structures, piping etc. and any other surface required to be painted. The painting system should ensure optimal protection of the installation with minimum need for maintenance, environmental friendly & easy to apply.

2.0 CODES AND STANDARDS

Painting of equipment shall be carried out as per the specifications indicated below and shall conform to the relevant IS contract for the material and workmanship.

The following Indian Standards may be referred to for carrying out the painting job:

IS: 5	:	Colours for ready mixed paints and enamels
IS: 101	:	All Parts and Sections for paint testing
IS: 1303	:	Glossary of terms relating to paints
IS: 2379	:	Colour code for identification of pipelines
IS: 1477	:	Code of practice for painting of ferrous metals in buildings (Parts I & II)
IS: 2524	:	Code of practice for painting of non-ferrous metals in buildings (Parts I & II)
IS: 6278	:	Code of practice for white washing and colour Washing
IS: 13183	:	Aluminium Paint, heat Resistant specification
IS: 158	:	Ready mixed paint, brushing, bituminous, black, Lead free, acid, alkali, water and heat resisting
IS: 2074	:	Ready mixed paint, air drying, red Oxide Zinc Chrome, priming
IS: 104	:	Ready mixed paint, brushing, Zinc Chrome, priming
IS: 2932	:	Enamel, synthetic, exterior (a) undercoating (b) finishing.
IS: 2629	:	Recommended Practice for Hot Dip Galvanising
BS EN ISO 14713	:	Code of practice for protection of iron & steel structure against corrosion
ISO 8501-1	:	Preparation of steel substrates before application of paint & related Products. Part-1: Rust grades & preparation grades of uncoated steel substrates & steel substrates after overall removal of previous coatings
ISO 8502-3	:	Assessment of dust on steel surface prepared for painting (Pressure sensitive tape method)
ISO 12944 (Part 1 to 7)		Corrosion protection of steel structures by Protective paint systems
SSPC	:	US Specifications of Steel Structures Painting Council, SSPC Volumes I and II
SSPC-SP-08	:	Surface preparation by Pickling
NORSOK M-501	:	Surface preparation & Protective coating
IS0 20340	:	Pre-Qualification test
ASTM	:	American Standard Test Method for paints and coatings
AWWA	:	American Water Works Association

SIS: 55900 : Swedish standard for blasting

In the event of conflict between the Codes and Standards referred to in the specification and the requirement of this specification, the latter shall govern. Statutory and Local regulations shall be strictly followed in selection and application of paint.

3.0 GENERAL

3.1 This specification covers the surface preparation, method of application and material to be used for all coating of equipment, steel structures and piping. Steel material subjected to surface preparation on shop/site shall have minimum requirements in accordance with Rust Grade B (SSPC/SSPM Volume-2).

3.2 Coating materials according to SSPC, EN ISO, ASTM, BIS or DIN standards, shall be used. The paint shall comply with applicable laws, regulations, ordinances etc., of the local authority, state or the nation pertains to the work. The materials shall be matched with each other so that they are compatible. Coatings deviating this specification shall be subject to approval. Standards of surface preparation and painting shall give a time to first maintenance of 10 years.

3.3 The paint to be applied shall be approved by Customer / Engineer.

3.4 All paints & paint material used shall be procured from approved manufacturers. Paint shall be supplied in manufacturers original containers with the description of content, specification No., colour, ref no, date of manufacture, shelf life expiry date & pot life.

3.5 The paint manufacturers shall provide coating system data sheet for each coating system to be used containing the following information:

1. Surface preparations
2. Film thickness (min and max)
3. Min and max recoating intervals at relevant temperatures
4. Mixing ratio, thinner details and coating repair systems

3.6 The sample for testing the paint being used may be taken by the customer at any time.

3.7 In general Shop fabricated equipment will be delivered to the site coated with a shop applied system or the manufacturer's standard finish in accordance with the requirements of this specification.

3.8 For equipment that has received shop prime coat, touch-up prime coat and additional coats shall be applied in accordance with the coating schedule. It is responsibility of the vendor to ensure compatibility between shop and field applied paint systems.

3.9 Necessary precautions shall be provided to all equipment, structures to protect other surfaces from abrasive blasting, coating over spray and spatter. Damage to other surfaces or equipment shall be repaired by the vendor.

3.10 The Contractor shall submit the following for review and approval by the Customer:

1. Manufacturer's recommended paint scheme for the project
2. Latest published product & instructions for application data,
3. Procedures for surface preparation and application.
4. Pre qualification for equipments and blasting materials, product, procedure and personnel qualifications for the paint and painting systems.
5. Painting repair procedures

Painting records shall contain:

- Equipment/components/location painted
- Date of painting
- Paint details such as specification No, colour, date of manufacture, shelf life, expiry date
- Application equipments
- Ambient conditions at the time of painting
- Surface temperature
- Drying time between coating, DFT and number of coatings
- Appropriate work plan for painting.

3.11 The supply of all necessary equipments, weather protection, and scaffolding for painting to ensure work is carried out in accordance with the specification and agreed programme.

3.12 Maintenance of the paint work until completion of the contract, this shall include repair of any damaged areas caused by third party.

3.13 Disposal of painting waste resulting from painting, shall comply with applicable laws, regulations, ordinances etc., of the local authority, state or the nation pertains to the work and coating materials.

3.14 It is a mandatory requirement that all operatives working to this procedure take full cognizance and implement necessary safety precautions.

4.0 PREPARATION OF SURFACES

4.1 All surfaces to be painted shall be thoroughly cleaned of all grease, oil, loose mill scale, dust, rust, weld spatters, sharp edges and any other foreign matter. Removal of grease and oil contamination shall be in accordance with SSPC-SP1 prior to cleaning process described below.

4.2 Mechanical cleaning by power tool and scrapping with steel wire brushes shall be adopted to clear the surfaces. However, in certain locations where power tool cleaning cannot be carried out, hand scrapping may be permitted with steel wire brushes and/or abrasive paper. Cleaning with solvents shall be resorted to only in such areas where other methods specified above have not achieved the desired results. Cleaning with solvents shall be adopted only after written approval of the Engineer.

4.3 The blast cleaned surface shall be checked for signs of salt contamination as per ISO 8502-6 &9. The maximum allowable level of contamination shall be 20 mg/m2. Surfaces that do not meet these criteria shall be reprocessed.

Mechanical Cleaning:

Manual/power tool cleaning shall be done as per grade St-2 or St-3, of ISO 8504-3. This method to be used for repair painting or on already painted

surface and in case of usage on new construction painting prior approval may be obtained from purchaser/engineer.

	Condition of surface	ISO 8504-3	SIS 055900	SSPC
Hand tool cleaning	Rusted	C St2	C St2	SP2
	Rusted and pitted	D St2	D St2	SP2
Power tool cleaning	Rusted	C St3	C St3	SP3
	Rusted and pitted	D St3	D St3	SP3

i) Grade St-2: Thorough scraping and wire brushing, machine brushing, grinding etc. This grade of preparation shall remove loose mill scale, rust and foreign matter. Finally the surface is to be cleaned with a vacuum cleaner or with clean compressed air or with clean brush. After preparation, the surface should have a faint metallic sheen. The appearance shall correspond to the prints designated St-2.

ii) Grade St-3: very thorough scraping and wire brushing, machine brushing, grinding etc. After preparing the surface, it should have a pronounced metallic sheen and correspond to the prints designated St-3.

Blast cleaning:

Compressors: Compressed air supply for blast cleaning shall be free of water and oil. Air compressors shall not be allowed to deliver air at 110deg C. The blasting activity shall be performed at ambient temperatures above 5ºC and relative humidity less than 85%. Steel temperature shall be 3ºC above dew point. Necessary safety precautions for equipment and operator shall be adhered to.

Abrasives: Abrasives used for blast cleaning carbon steel and alloy steel shall be as per ISO 8504-2 and SSPC painting manual. Suggested abrasives may be chilled iron grit or shot steel and malleable iron grit and shots non metallic abrasive (aluminium oxide, copper slag, garnet etc.).

Removal of mill scale and rust using abrasives such as grit or shot under high pressure. The grade of blasting performed in line with the approved painting scheme.

Surfaces to be coated shall be free of all grease, oil, loose rust, and loose mill scale. Rust, mill scale, weld spatter, flux, shall be removed by the methods indicated in the Coating Schedule. Oil and grease shall be removed by solvent cleaning method as outlined in SSPC - SP – 1 prior to blasting.

The quality and grain size of abrasives and the parameter of their use are to be chosen to obtain the surface profile depth and cleanliness. Abrasives shall comply with applicable laws, regulations, ordinances etc., of the local authority, state or the nation pertaining to the work.

Profile measurements for abrasive blast cleaned surface shall be made with a Profile comparator and permanent record shall be maintained with Testex Press-O-Film.

Surfaces prepared for coating shall be coated the same day and before any visible rusting occurs (the time elapsed between blast cleaning and

commencement of painting shall under no circumstances exceed 4 hours, but in any case must commence before signs of degradation occur).

After blasting cleaning, depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 25 mm may be used.

The grades of surface finish:

	ISO 8501-1	SIS 055900	SSPC	NACE
White metal	Sa3	Sa3	SP5	1
Near White metal	Sa 2½	Sa 2½	SP10	2
Commercial blast	Sa2	Sa2	SP6	3
Brush off blast	Sa1	Sa1	SP7	4

Paint Application

General:

Paints and other coating materials shall be applied in accordance with the paint manufacturer's instructions. The surface preparation and painting system shall be as described in ANNEXURE with the following exceptions:

- Nameplates, code stampings and push buttons
- Concrete brickwork, tile, and glass unless specified by the Purchaser / Engineer
- Non-ferrous materials
- Austenitic stainless steel
- Plastic and / or plastic coated materials
- Insulated surface of equipment and pipes except colour coating wherever required
- Any surface specified by the Purchaser / Engineer not to be painted.

Paint Application Requirements

The paint shall be applied in accordance with the paint manufacturer's product data sheet, which shall include the mix ratio, the method of application, and the use of thinners and over coating times.

Paint application shall be by brush, roller or spray gun. Local regulations regarding spray and roller coating shall be observed. A smooth uniform film shall be applied to the surfaces to be coated.

Painting shall be performed when the temperature of the surface is greater than 3ºC above the dew point of the surrounding air and relative humidity of the air is less than 85% unless local conditions dictate otherwise and the Customer is in agreement. Guidance on the estimation of the probability of condensation can be found in ISO 8502-4. The measurement of these conditions is the responsibility of the Vendor.

In addition, paints shall not be applied under the following conditions:

- When the surface temperature is greater than 60 ºC (unless a higher temperature is agreed by the paint manufacturer)

- When the air temperature is less than approximately 5ºC, (depending on local conditions)

- When there is the likelihood of an unfavourable change in weather conditions within two hours after painting

- When there is a deposition of moisture in the form of rain, condensation, frost, etc., on the surface.

- When the available light is less than 500 lux.

Paints shall not be applied within 50 mm of edges which will later have to be welded. Such weld areas shall be taped/one coat of weldable primer for distance of 50 mm either side of the weld line.

When zinc rich primers are used, care shall be taken to mask to avoid any possibility of over spraying onto duplex, austenitic stainless steels; nickel alloys or 9% nickel steel components.

Two pack coatings like Air drying epoxy, Polyurethane coatings etc shall be mixed in the ratio recommended by manufacturer to ensure proper and complete curing of the coatings. The base and hardener are to be separately mixed first to obtain a homogenous mixture. The hardener is to be added to the base slowly, with continuous mixing / agitation and not the reverse. Power agitation is preferred over hand mixing.

Any addition of thinner to achieve the application viscosity should be made only after the components are thoroughly mixed. Excess thinner is not recommended, as increase in volume, leads to lower DFT, sagging, longer curing time, etc.
Coating containing heavy or metallic pigments that have a tendency to settle shall be kept in suspension by continuous use of a mechanical agitator whilst being applied, to ensure uniformity over the surface area (e.g., zinc MIO's pigmented materials).

Transport and erection of painted structures shall be carried out only after the drying time specified by the paint manufacturer has elapsed. Handling & packing of painted material shall be appropriate to avoid damage to painting, such as the use of non-metallic slings, etc for handling and by minimising handling after painting. All steel equipment shall be provided with priming or coating system to protect the steel surface during transport, storage, installation and construction.

Spray Application

Airless or pneumatic spray applications are preferred methods of application. Spraying shall be carried out keeping the spray gun at the minimum suitable distance from the work piece and consistently at 90° to the surface being painted.

Approval of Purchaser / Engineer shall be obtained during spray painting which may cause interference to other works. If spray painting is to be carried out, the following shall be taken into account:

The correct spray tips, air pressures, etc, as recommended by the equipment supplier, shall be used.

Conventional air spray equipment is used, the correct combination of air volume, air pressure and fluid flow to give good atomisation to be ensured to

get a defect free painted surface. The major disadvantage of conventional air spray is that high build coatings can generally not be applied by this method as most paints have to be thinned to a suitable viscosity for satisfactory atomisation, and so lose their high build properties. Vendor shall follow manufacture's instruction.

Air spray (pressure pot) is recommended in cases where large quantities of paint are to be applied as paint in the tank can be prevented from settling, reduces application time and also enables the gun to be turned to any angle to coat objects effectively without spilling paint.

Airless spray is recommended as high build coatings can be applied without thinning, very rapid application is possible, giving an economic advantage, compared to conventional spray, overspray and bounce-back are reduced, leading to reduced losses of material and less dust and fume hazards.

Each coat shall be applied uniformly and completely over the entire surface. All runs and sags shall be brushed out immediately or the paint shall be removed and the surface re-sprayed.

Very complex structures should be painted by brush instead of spray gun to avoid overspray, dry spray and unacceptable paint losses.

Brush application

Brush application may be used under the following circumstances:

- When areas cannot be properly coated by spraying for reasons such as material or environmental considerations
- For the initial coat of paint to corners, edges, crevices, holes, welds or irregular surface prior to spray application
- For"touch up" or repairs to localize damaged paint or areas of incorrectly applied paint
- Where the paint manufacturer considers the coating material suitable for brush application.

Brushes shall be of a style and quality that will permit the proper application of paint.

Brush applications should be done in two passes that are perpendicular to each other 'wet on wet" so that a smooth coat, as near uniform in thickness as possible, is obtained thereby avoiding running and droplets. There should be no deep or detrimental brush marks. Paint shall be worked into all crevices and corners. Runs and sags shall be brushed out.

During the application of each coat, all areas such as corners, edges, welds, small brackets, bolts, nuts and interstices shall receive additional paint to ensure that these areas have at least the minimum specified dry film thickness and to ensure continuity of coating.

Roller application

Roller application shall only be used on relatively large surface areas and only if spraying is not on option. Roller application shall only be used if the first or priming coat of paint has been applied by brush. Roller application shall be in accordance with the paint Manufacturer's instructions.

Coating materials

The selected coating materials shall be suitable for the intended use and shall be selected after an evaluation of all relevant aspects such as

- Corrosion protective properties
- Requirements to health, safety and environment
- Properties related to application conditions, equipment and personnel
- Experience with the coating materials and coating system.

All coating materials and solvents shall be protected from ignition sources and shall remain within storage temperatures and storage conditions recommended by the coating manufacturer. All coating materials and solvents shall be stored in the original container bearing the manufacturer's label and instructions. Performance standard as listed below shall be established by paint manufacturer the records shall be submitted for review.

- Adhesion test (pull off test)
- Flexibility test
- Salt spray test (min 1000 Hrs)
- Water absorption test
- UV resistance test (external coating)
- Cathodic disbonding test (internal coating)
- Abrasion test (internal coating)
- Impact resistance test
- Sea water immersion test (structures in tidal, splash zone and conveying sea water)

Each product shall have a batch number showing year and month of manufacture and giving full traceability of production. Shelf life shall be included in the technical data sheet. All coating materials and solvents shall be stored in the original container bearing the manufacturer's label and instructions.

The composition of the paint shall be at the discretion of the manufacturer, provided that the finished product meets the requirements of, State or Local regulatory bodies for the products. All vehicle components for use in the manufacture of paints and enamels shall meet the ASTM/ ISO Specification except as otherwise stated coating systems shall be selected as per corrosivity category listed in the table below. Coating systems are tabulated in ANNEXURE and shall be pre-qualified in accordance with specification. Coating systems/ alternative coating systems may be re-subjected to pre-qualification, at the discretion of OWNER/ ENGINEER. The specified coating systems, the number of coats and the coating film thicknesses given in Annexure are minimum requirements Top coat colors should be in accordance with Annexure.

Gratings and step threads

i) Surface preparation

Gratings and step threads shall be cleaned by acid pickling as per SSPC-SP-08.

ii) Hot dip galvanising

The hot dip galvanising shall be done as per IS 2629 .The average mass of coating shall be 610 gms/m^2.

iii) Post galvanising treatment

Immediately after galvanising, post treatment such as chromating shall be applied to retard white rust attack.

iv) Touch up mechanical damages

The repair of damages coatings shall be done as per the recommended practice ASTM A 780.

CORROSIVITY OF ENVIRONMENTS

Corrosivity category		Mass loss per unit surface (per year of exposure)	
		Mass loss g/mm²	Thickness loss µm
C2	Low	>10 to 100	>1.30 to 25
C3	Medium	200-400 g/m2	(25-50µm)
C4	High	400-650 g/m2	(50-80µm)
C5	Very High Industrial & marine	650-1500g/m2	(80-200µm)

Tests required for evaluation of acceptance of coating materials:

TABLE -1

PERFORMANCE TEST OF PAINT

SL. No.	**Test**	**ASTM TEST METHOD**
1.0	Abrasion Resistance: (topcoat only)	ASTM D4060
2.0	Adhesion:	ASTM D4541
3.0	Dry Heat Resistance:	ASTM D2485
4.0	Flexibility: (topcoat only)	ASTM D522, 180° bend
5.0	Pencil Hardness: (topcoat only)	ASTM D3363
6.0	Salt Fog Resistance:	ASTM B117, 1000 hours
7.0	Weather Resistance:	ASTMG23 Type D
8.0	Test	ASTM Test Method
9.0	Density	D 1475
10.0	Dipping properties	D 823
11.0	Drying time	D 1640
12.0	Flexibility	D 1737/D 522
13.0	Hardness	D 3363
14.0	Adhesion (pull off test)	D 4541
15.0	Abrasion resistance	D 968/D 4060
16.0	DFT/Coat	As per SSPC Guidelines
17.0	Storage Stability	D 1849
18.0	Resistance to	
	i) Humidity for 2000 hrs.	D 2247
	ii) Salt Spray for 2000 hrs.	B 117
	iii) Accelerated Weathering	D 822

INSPECTION:

Inspection will be performed by an inspector authorised by Purchaser / Engineer. Paint materials including primers and thinners brought to site by contractor for application shall be procured directly from manufactures as per specification and shall be accompanied by manufacturer's test certificates.

The painting work shall be subjected to inspection by purchaser / engineer at all times. The vendor shall offer following stage of inspection:

- Surface preparation
- Primer application
- Subsequent coats
- Paint qualification test

Vendor shall provide the expert technical services of the paint manufactures as and when required by purchaser / engineer to ensure both the surface preparation and applications are carried out as per their recommendations. This service shall be provided without any obligation to purchaser.

The following coating inspection & test shall be carried out:

1. Ambient and steel temperature, relative humidity and dew point min twice in a shift.

2. Surface finish & profile check each component or once per 10 m2 after surface preparation.

3. Salt contamination test - Free from salt contamination.

4. Dry Film Thickness as per ISO 2808 No.6.

5. Holiday Test as per ASTM D 5162/ NACE RP 0188.

6. Adhesion Test as per ISO 2409 for cross-cut test, or a pull-off test as per ISO 4624/ ASTM D 4541.

6.0 SUGGESTED COLOUR CODES FOR PAINTING:

Sl. No.	Item/Service	Colour	IS-5	Colour (Band)	IS-5
1.0	Structures, platforms, ladders and handrails	Dark Admiralty Grey	632		
2.0	Boiler casing, ESP and ducting	Nut Brown	413		
3.0	Fans, pumps, motors,	Light Grey	631		
4.0	Tanks (without insulation and cladding)				
4.1	Outdoor	Aluminium			
4.2	Indoor	Light grey	631		
5.0	Vessels & all other proprietary equipment (without insulation & cladding)	Light grey	631		
6.0	Switchgear	Light grey	631		
7.0	Control & relay panels	Light grey	631 78 of IS1650		
8.0	Turbine	Golden	356		

Sl. No.	Item/Service	Colour	IS-5	Colour (Band)	IS-5
		Yellow			
9.0	Generator & exciter	Light grey	631		
10.0	Transformers	Aluminium			
11.0	Machinery guards	Signal red	537		
12.0	Crane				
12.1	Crane structure	Golden Yellow	356		
12.2	Trolley and hook	Crimson	540		
13.0	Piping (without insulation and cladding)				
13.1	Water System				
13.1.1	Boiler feed	Sea green	217		
13.1.2	Condensate	Sea green	217	Light brown	410
13.1.3	Bearing cooling water	Sea green	217	French blue	166

Notes:

1. This colour code basically refers to IS: 2379 for piping with necessary modifications.

2. Where band colour is specified, same shall be provided at 30 meter intervals on long uninterrupted lines and also adjacent to valves and junctions.

PAINTING SCHEME FOR C2 AMD C3 ENVIRONMENT

S. No	Description	Surface Preparation	Primer			Intermediate paint			Finish coat			Total DFT
			Paint	No. of coats	DFT	Paint	No. of coats	DFT	Paint	No. of coats	DFT	Min.
1.	Boiler structure, un-insulated ducts, suspensions, hangers temperature <120^{0}C	Sa 2 ½	In organic Zn silicate	2	80 µ	HB MIO epoxy	1	120 µ	Poly eurethene	2		260µ
2.	Indoor structure	Sa 2 ½	HB Zn Phospate	2	80 µ	HB MIO epoxy	1	120 µ	--	--	--	260µ
3.	Insulated parts exposed to temp >120^{0}C	Sa 2 ½	In organic Zn silicate	2	60 µ							60µ
4.	Work shop	Sa 2 ½	HB Zn Phospate	2	80 µ	HB MIO epoxy	1	120 µ	--	--	--	260µ
5.	Water Treatment Plant (external)	Sa 2 ½	Zn rich epoxy	2	80 µ	HB MIO epoxy	2	200 µ	Aliphatic poly eurethene	2	80 µ	360µ
6.	Coal Handling Plant	Sa 2 ½	In organic Zn silicate	2	80 µ	HB MIO epoxy	1	120 µ	poly eurethene	2	60 µ	260µ
7.	Fuel pipings	Sa 2	Ehthy Zn silicate	1	40 µ				HR aluminium paint	2	40 µ	80µ
8.	Un insulated silencer, steel stacks >120^{0}C	Sa 2 ½	Ehthy Zn Silicate	1	40 µ				HR silicone aluminium paint	2	40 µ	80µ
9.	Above ground piping	Sa 2 ½	In organic Zn silicate	2	80 µ	HB MIO epoxy	1	120 µ	Poly eurethene	2	60 µ	260µ
10.	Burried piping (External)	Sa 2 ½	Coal tar primer, coal tar enamel, inner wrap of fibre glass, final outer wrap of enamel impregnated fibre									4.0mm
11.	Burried piping (Internal)	Sa 2 ½	Solid rigid poly eurethene 500 µ									500µ
12.	Storage tanks (external)	Sa 2 ½	In organic Zn silicate	2	80 µ	HB MIO epoxy	1	120 µ	Poly eurethene	2	60 µ	260µ
13.	Storage tanks (internal)	Sa 2 ½	3 coats of amine adducts									400µ

14.	DM water piping (internal)	Sa 2 ½	Hard rubber lining min 4 mm thickness									4. mm
15.	DM water tank (internal)	Sa 2 ½	In organic Zn silicate	2	80 µ	HB MIO epoxy	1	150 µ	HB coal tar epoxy	1	150 µ	380µ
16.	Fuel oil tanks (internal)	Sa 2 ½	In organic Zn silicate	2	80 µ	HB MIO epoxy	1	150 µ	HB coal tar epoxy	1	150 µ	380µ
17.	Insulated parts continuously exposed to condensing water	Sa 2 ½	In organic Zn silicate	2	75 µ							75µ
18.	For insulted piping <125^{0}C	Sa 2 ½	Polyamide cured epoxy coasting	2	250 µ							250µ
19.	Electrical parts, control panels, valves, pumps & motors (indoor)*	Sa 2 ½	Zn phosphate epoxy	2	80 µ				Chlorinated rubber	2	80 µ	160µ
20.	Electrical parts, control panels, valves, pumps & motors (outdoor)*	Sa 2 ½	Zn phosphate epoxy	2	80 µ				Chlorinated rubber	2	100 µ	180µ
21.	Switch yard, floor grills walk ways	Sa 2 ½	Hot dip galvanising 80µ									80µ

* Note: Manufacturer to specify details of painting system capable of withstanding environmental conditions for a period of 10 years before first maintenance

PAINTING SCHEME FOR C4 AMD C5 ENVIRONMENT

S. No	Description	Surface Preparation	Primer			Intermediate paint			Finish coat			Total DFT
			Paint	No. of coats	DFT	Paint	No. of coats	DFT	Paint	No. of coats	DFT	Min.
1.	Boiler structure, un-insulated ducts, suspensions, hangers temperature <120^{0}C	Sa 2 ½	HB Zn Phospate	2	80 µ	HB MIO epoxy	2	200 µ	Epoxy PU HB	2	80 µ	360µ
2.	Indoor structure	Sa 2 ½	HB Zn Phospate	2	80 µ	HB MIO epoxy	1	120 µ	Poly eurethene	2	60 µ	260µ
3.	Insulated parts exposed to temp >120^{0}C	Sa 2 ½	In organic Zn silicate	2	60 µ							60µ
4.	Work shop	Sa 2 ½	HB Zn Phospate	2	80 µ	HB MIO epoxy	1	120 µ	Poly eurethene	2	60 µ	260µ
5.	Water Treatment Plant (external)	Sa 2 ½	Zn rich epoxy	2	80 µ	HB MIO epoxy	2	200 µ	Epoxy PU HB	2	80 µ	360µ
6.	Coal Handling Plant	Sa 2 ½	HB Zn Phospate	2	80 µ	HB MIO epoxy	2	200 µ	Poly eurethene	2	60 µ	340µ
7.	Coal Fuel pipings	Sa 2	Ehthy Zn silicate	1	40 µ				HR aluminium paint	2	40 µ	80µ
8.	Un insulated silencer, steel stacks >120^{0}C	Sa 2 ½	Ehthy Zn Silicate	1	40 µ				HR silicone aluminium paint	2	40 µ	80µ
9.	Above ground piping	Sa 2 ½	In organic Zn silicate	2	80 µ	HB MIO epoxy	1	120 µ	Poly eurethene	2	60 µ	260µ
10.	Burried piping (external)	Sa 2 ½	Coal tar primer, coal tar enamel, inner wrap of fibre glass, final outer wrap of enamel									4.0 mm
11.	Burried piping (internal)	Sa 2 ½	Solid rigid poly eurethene 500 µ									500µ
12.	Storage tanks (external)	Sa 2 ½	In organic Zn silicate	2	80 µ	HB MIO epoxy	2	200 µ	Poly eurethene	2	60 µ	340µ
13.	Storage tanks (internal)	Sa 2 ½	3 coats of amine adducts									400µ
14.	DM water piping (internal)	Sa 2 ½	Hard rubber lining min 4 mm thickness									4.0

												mm
15.	DM water tank (internal)	Sa 2 ½	In organic Zn silicate	2	80 µ	HB MIO epoxy	1	150 µ	HB coal tar epoxy	1	150 µ	380µ
16.	Fuel oil tanks (internal)	Sa 2 ½	In organic Zn silicate	2	80 µ	HB MIO epoxy	1	150 µ	HB coal tar epoxy	1	150 µ	380µ
17.	Insulated parts continuously exposed to condensing water	Sa 2 ½	In organic Zn silicate	2	75 µ							75µ
18.	For insulted piping <125^{0}C	Sa 2 ½	Polyamide cured epoxy coasting	2	250 µ							250µ
19.	Electrical parts, control panels, valves, pumps & motors (indoor)*	Sa 2 ½	Zn phosphate epoxy	2	80 µ				Chlorinated rubber	2	80 µ	160µ
20.	Electrical parts, control panels, valves, pumps & motors (outdoor)*	Sa 2 ½	Zn phosphate epoxy	2	80 µ				Chlorinated rubber	2	100 µ	180µ
21.	Switch yard, floor grills walk ways	Sa 2 ½	Hot dip galvanising coating Wt. 610 gms/M^2 (coating thickness of 80µ)									80µ

*** Note:** Manufacturer to specify details of painting system capable of withstanding environmental conditions for a period of 10 years before first maintenance.

STORAGE OF EQUIPMENT / GOODS AT SITE

1.0 SCOPE

1.1 This specification details the general guidelines for storage of mechanical and electrical equipment at site from the date equipment are taken over by the CONTRACTOR until the same are erected and handed over to the OWNER.

1.2 The equipment covered under this specification shall be stored in the type of storage as recommended by the MANUFACTURER/OWNER/CONSULTANT.

2.0 CONSTRUCTION OF STORES

2.1 Normally, the OWNER makes available the space for the CONTRACTOR to construct the necessary stores as specified.

2.2 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 wasteful handling during retrieval of items required for erection.

2.3 The outdoor storage areas as well as semi-closed stores shall be provided with adequate drainage facilities to prevent water logging. The CONTRACTOR shall check the satisfactoriness of these facilities prior to monsoon.

2.4 The stores 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.

2.5 In case of storage of certain equipment / materials, it may be necessary to maintain specified temperature ranges. In such cases, it is the responsibility of the CONTRACTOR to provide adequate heating / air conditioning facilities on round the clock basis. The CONTRACTOR shall check that space heaters, heating bulbs and air conditioners are kept energised continuously as applicable. In the event there is a prolonged failure of electric power, rendering such air-conditioners/space heaters inoperative, the CONTRACTOR shall make alternative arrangements to ensure that items under storage do not suffer any damage / deterioration on this account.

2.6 Adequate lighting facility shall be provided by the CONTRACTOR in storage areas and storage sheds and security personnel positioned to ensure enforcement of security measures to prevent theft and loss of materials entrusted to him by the OWNER. The CONTRACTOR shall carry out regular inventory of materials received, issued and erected and notify the OWNER of any loss when noticed.

2.7 The CONTRACTOR shall provide adequate number of competent stores personnel including store-keepers, clerical staff, inspection engineers, watchmen and security staff to efficiently store and maintain the equipment / material entrusted to him.

2.8 Where necessary, the CONTRACTOR shall provide necessary space heating and other protective care to equipment in case it will take a long time to haul them

to the stores. Any equipment left in the open under such conditions shall be, if required, covered with tarpaulin.

3.0 MAINTENANCE DURING STORAGE

3.1 Where unloading from the carriers and transport to warehouses is excluded from the CONTRACTOR'S scope .The CONTRACTOR shall take over the materials from the OWNER'S storage area / sheds.

3.2 Where materials is unloaded by the OWNER before the CONTRACTOR arrives at site or even when the CONTRACTOR is already at site, the OWNER can hand over the material to the CONTRACTOR and thereupon it will be the responsibility of the CONTRACTOR to store and maintain these material in a proper and approved manner.

3.3 While taking over the materials, the CONTRACTOR shall carry out inventory and inspection of the same and submit a report of his observations to the OWNER. After taking over of the equipment / materials, the CONTRACTOR is solely responsible for the same until handing over to the OWNER the erected plant and surplus materials, if any. The CONTRACTOR is responsible for maintenance of the equipment / materials in storage, during erection and until commissioning including protection of the same against theft, elements of nature and corrosion damages. In case commissioning of the equipment is delayed, the CONTRACTOR shall be responsible for maintenance of the erected plant and equipment as directed by OWNER / CONSULTANT.

3.4 The CONTRACTOR shall repack the equipment after inspection and store the same 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.

3.5 The CONTRACTOR shall carry out frequent inspection of materials stored and also extend necessary facilities to the OWNER / CONSULTANT to carry out such inspection, when considered necessary. The CONTRACTOR shall implement the suggestions of the OWNER/CONSULTANT in this connection.

3.6 At no time shall any materials be stored directly on ground. All materials shall be stored minimum 200 mm above the ground by providing good wooden sleepers.

3.7 Welded and cast units shall be stored in such manner that there is no danger of distortion.

3.8 All special measures to prevent corrosion shall be taken by the CONTRACTOR.

3.8.1 Materials which carry protective coating shall not be wrapped in paper, cloth, etc., as these are liable to absorb and retain moisture. The CONTRACTOR shall inspect the materials and in case of signs of wear or damages to protective coating, that portion shall be cleaned with carbon tetra chloride or any other approved solution and coated with an approved protective paint. Complete record of all such observations and protective measures taken shall be maintained.

3.9 While handling the equipment, no dragging on the ground is permitted. The CONTRACTOR shall submit his scheme for handling major pieces of equipment

for approval by the OWNER / CONSULTANT prior to actual handling of the same. In cases where a scheme is recommended by the OWNER / MANUFACTURER, it shall be strictly adhered to.

3.10 The CONTRACTOR shall periodically inspect materials with specific reference to

3.10.1 Ingress of moisture and corrosion damages.

3.10.2 Damage to protective coating.

3.10.3 Open ends in pipes, vessels and equipment. In case any open ends are noticed, the CONTRACTOR shall get them capped.

3.10.4 Insulation of electrical equipment. Regular insulation checks are essential and these values shall be properly logged.

3.10.5 Any damages to equipment / materials.

a) In case of any damages, these shall be promptly notified to the OWNER. In all cases, the repairs / rectification shall be carried out strictly as directed by the OWNER / CONSULTANT.

b) If such repairs / rectification is necessitated due to causes attributable to the CONTRACTOR, such repairs / rectification shall be carried out at no extra cost to the OWNER. In other cases, compensation for such repair / rectification works will be as mutually agreed to.

c) In case such damages are attributable to the CONTRACTOR and if, in the opinion of the OWNER/ CONSULTANT, the CONTRACTOR is not competent to carry out necessary repairs / rectification, the OWNER shall get this done by any other agency and recover the expenditure incurred by him from the CONTRACTOR.

4.0 MODES OF STORAGE

Given below are the general guidelines for storage of various equipments under the broad storage classifications. Wherever the specific recommendations of the MANUFACTURER/OWNER/CONSULTANT are at variance with what is indicated below, the former shall prevail.

4.1 Special Storage – Air Conditioned

The following materials are normally stored in air conditioned storage.

4.1.1 Welding Electrodes

These deteriorate under adverse conditions of storage and are preferably stored in air conditioned storage. As an alternative, if approved, these can also be stored in hot boxes / ovens.

It is essential to regularly inspect the conditions of electrodes and ensure that temperature is maintained within specified range at all times.

4.1.2 Ball, needle and ro ller bearings: These shall be stored in their original packing.

4.1.3 **Photographic materials and films**: These shall be stored in their original moisture vapor proof packages.

4.1.4 **Rubber Goods**: These shall be protected against sunlight and artificial light as well as high humidity conditions.

4.1.5 **Hydraulic / Electronic equipment / instruments and components** - These shall be stored in sealed packages.

4.2 Closed storage

The following materials are normally stored in closed storage.

4.2.1 Cement bags.

4.2.2 All small parts / components liable to be misplaced / lost. These shall include the following:

a) Small structural cleats, bolts, nuts, washers, etc. High tensile bolts and nuts shall be stored in separate sealed boxes with proper identification to avoid mix up with other items

b) Pipe hangers, spring hangers, etc. The identification numbers on spring hangers shall be carefully preserved during storage

c) Stainless steel and copper tubes, pipe fittings, etc.

d) Electrical clamps, cable boxes, cable glands, ferrules, fuses, control cables, copper cables and grounding strips, push button switches, etc.

e) Pilot valves, pull rods, keys, control valves. These shall be greased, wrapped in paraffin paper and stored in packing boxes

f)Turbine governing system components

4.2.3 All loose turbo generator parts, turbine sole plates and packing plates, bolts and studs.

4.2.4 Generator and turbine rotors, stators, bearings, liners, control gears, etc.

4.2.5 Boiler fine fittings, soot blowers, mill and fan bearings, hangers and couplings.

4.2.6 Electrostatic precipitator electrodes, connecting links, etc.

4.2.7 Drive units of regenerative air heaters, fans, mills, etc., motors, pumps, blowers, ejectors and compressors, including those supplied disassembled.

4.2.8 Oil and hydrogen coolers.

4.2.9 Seal oil and gas control system equipment.

4.2.10 All indoor switch gear equipments.

4.2.11 Bus ducts, exciters, excitation system equipment, voltage regulators, circuit breakers, potential and current transformers, lightning arrestors, bushings, storage batteries and cells.

4.2.12 All instrument parts such as measuring instruments, controllers and regulators, interlock system, control drive units, gauges, instrument valves, thermocouples and leads.

4.2.13 Thermal and insulation materials. Mineral wool, glass wool, castable refractories, fire bricks, asbestos, etc.

4.2.14 DM plant chemicals and resins.

4.2.15 Synthetic paints. Normally in separate stores.

4.3 Semi-Closed Storage

The following materials are normally stored in semi-closed storage.

4.3.1 Condenser tubes stored in boxes.

4.3.2 Dust collector elements in boxes.

4.3.3 Coal mill liners, shell, coal feeders and gates, separator assembly.

4.3.4 Boiler dampers, manhole doors, mountings, casing frames, buck stays, Air pre-heater frames tubes, baskets. Burner panels and burners, Electrostatic precipitator shell, discharge and collecting plates.

4.3.5 Fan impellers, large assembled pumps, compressors, crushers, pulleys and idlers, wagon tippler drive assemblies and bearings, outdoor motors, etc..

4.3.6 Large C. I. Valves, butterfly valves, stop and control valves, expansion joints.

4.3.7 Outdoor switch gears and panels, small transformers, cable tray parts, etc.

4.3.8 Crane rope drums, hoists, trolleys. Wire ropes in drums covered with tarpaulin.

4.3.9 Bearing stands

4.3.10 Conveyor belts

4.4 Open Storage

The following materials are normally stored in open storage.

4.4.1 Fabricated and un-fabricated structural steel members, Chimney steel, stairways and hand rails. Gallery steel Crane bridges and steel members, Reinforcement steel.

4.4.2 Coarse aggregates and sand.

4.4.3 Un-fabricated pipes and fabricated pipe assemblies, Concrete and hume pipes. Large diameter conduits / pipes in boxes, Ash disposal pipes.

4.4.4 Boiler, drum, tubes, tube panels and headers.

4.4.5 Mill drums, bunker plates, etc.

4.4.6 Condenser shell parts, water boxes, etc.

4.4.7 Air pre-heater tube plates.

4.4.8 De-aerators, feed water heaters, etc.

4.4.9 Conveyor steel, and wagon tippler parts except drive units

4.4.10 Pressure vessels, reaction towers and columns, Fabricated vessels and tanks shall have their openings firmly blanked.

4.4.11 Flocculator Bridge, D.M. plant filters, vessels, etc.

4.4.12 Cable drums

4.4.13 Large power transformers

5.0 SPECIFIC GUIDELINES FOR STORAGE

Given below are the guidelines for certain other major equipment / materials. These are broad guidelines only and storage shall be strictly as directed by the Manufacturer / OWNER / CONSULTANT.

5.1 Condenser

Condenser shells shall be stored on sleepers in open storage. The materials shall be kept resting in such a manner that there is no distortion to the assemblies. The bracings provided at the factory shall not be disturbed. Handling shall be strictly as per the recommendations of the Manufacturer. The tube sheets shall be protected against corrosion and tube holes against scratches. The condenser tubes shall be inspected on receipt and stored in boxes in which they are reviewed.

5.2 Deaerator

The deaerator shall be drained of water and stored dry. The nozzles shall be sealed / capped. If trays are delivered separately, these shall be stored on racks in closed storage.

5.3 Feed Water Heaters, Heat Exchangers, Vessels and Bearings

5.3.1 These equipment shall be drained of water and stored dry, with openings and flanges sealed / capped.

5.3.2 The hooks, eye bolts, etc., provided shall be used for handling these equipment.

5.3.3 All machined surfaces shall be coated with approved protective coating at regular intervals.

5.3.4 Heat exchangers shall be stored in horizontal position.

5.4 Rotating Equipment such as Pumps and Compressors

5.4.1 These are normally stored in assembled condition in closed / semi-closed storage. When stored in semi-closed storage, they shall be covered with tarpaulin and bed plates shall rest fully on sleepers.

5.4.2 The CONTRACTOR is responsible for proper lubrication of these equipment as directed.

5.4.3 The gear boxes and oil sumps shall be kept filled with recommended lubricating gear oil. The couplings and bearings shall be covered with approved grease and nozzle flanges screwed with caps or suitably plugged.

5.4.4 Pumps, if delivered in dis-assembled condition, shall be stored with the parts properly greased and wrapped in paraffin paper. Smaller parts are to be stored on racks whereas larger parts on sleepers in closed storage. Occasional flushing with hot lubricating oil may have to be carried out, if so directed; in the cases of equipment such as boiler feed pump.

5.4.5 The shafts of rotating equipment shall be turned by 90° every week to avoid rotor journals from rusting and to ensure that shaft is free to rotate.

5.4.6 The CONTRACTOR shall maintain record of lubrication with details of lubricants used as well as protective measures carried out.

5.5 Piping and Valves

5.5.1 All pipes shall be stored on sleeper beds with open ends securely capped. The beveled ends shall be protected with a coating of approved grease. If so directed, inside surfaces of piping shall be coated with approved protective solution.

5.5.2 Pipes shall be neatly arranged and stacked for easy identification and retrieval.

5.5.3 Pipes shall be blown with air prior to installation and it shall be ensured that there is no obstruction.

5.5.4 Valves shall be stored with the discs screwed down on the seat so that packing surfaces are not exposed to dust. All machined surfaces shall be covered with grease. Preservation of identification tags is essential to avoid installation in a wrong service.

5.6 Switch gear & Control Panels

5.6.1 Depending on whether these are of indoor or outdoor design, these shall be stored in closed / semi-closed storage.

5.6.2 The spaced heaters, where provided, shall be kept connected with power supply irrespective of mode of storage where space heaters are not provided, use of adequate number of heating bulbs is recommended.

5.6.3 Insulation resistance shall be measured at regular intervals and megger values properly logged.

5.7 Transformers

5.7.1 It is advisable to assemble and set the transformer filled with oil in its permanent location soon after receipt even if it is not likely to be put in service for a while. In case of gas filled transformers, a positive pressure should be maintained during storage as recommended by the Manufacturer. If transformer is to be stored partially or fully dis-assembled, it shall be protected against moisture ingress / absorption by keeping them immersed in

transformer oil or as recommended by the MANUFACTURE / OWNER / CONSULTANT.

5.7.2 Prior to charging any transformer, it is essential to check the satisfactoriness of insulation values and di-electric strength of oil.

5.8 Cells, Accumulators, Batteries

These shall be stored in a dry and well ventilated place and protected from extreme cold. Internal parts of large cells are loose and the cells should be handled with care to avoid displacement of internals. Saw dust shall never be used for packing batteries as it is hygroscopic.

5.9 Cables

Cable drums if stored indoors shall be in dry, ventilated stores. Cables are normally supplied with ends sealed. When a length is cut, the end should be resealed. The drums shall be stored with adequate spacing between them for better air circulation.

5.10 Motors

Besides general procedures such as regular inspection and recording of insulation resistances, in the case of LT motors, if so recommended, low voltage current flow through the windings may be maintained during storage.

5.11 Instruments

5.11.1 These are stored on racks in closed storage and in air conditioned storage if so recommended. These shall be stored in their packages in dry condition and shall be handled with extreme care.

5.11.2 Instrument flanges and nozzles, if directed, shall be coated with technical Vaseline.

5.11.3 In the case of fragile instruments, the storage shall be in a separate zone away from where heavy materials are stored to minimise danger of damage.

5.12 STEEL

5.12.1 Reinforcement steel:

Reinforcement steel shall not be kept in direct contact with the ground but stacked on top of an arrangement of timber sleepers or the like. If stored for long periods, these may be coated with cement wash before stacking to prevent loose scales and rust. Fabricated reinforcement shall be carefully stored to prevent damage, distortion, corrosion and deterioration.

5.12.2 Structural steel:

Structural steel could safely be stored in open storage but with sufficient space in between for handling and crane movement. All steel shall be stored 200 mm above ground on suitable packing to avoid damage. It should be stored according to sizes and sections preferably in the order required for erection. The area for open storage should be properly graded to avoid water logging in the storage area. Steel shall not be stored in the vicinity of areas where excavation or grading will be done. Scratched or abraded steel shall be given a

coat of primer for protection after unloading and handling prior to erection. All milled and machined surfaces shall be properly protected from rust / corrosion by suitable coating.

5.13 Cement

5.13.1 Cement shall be stored in bags in a separate shed away from where mechanical and electrical equipment are stored to minimise the possibility of cement dust settling on the equipment.

5.13.2 The storage shed where cement is stored shall be absolutely water tight. The flooring shall be a 15 mm thick concrete slab laid on a dry course soling or as recommended. The ground shall be drained away from the shed to prevent accumulation of water in its vicinity.

5.13.3 The bags shall be neatly stacked with adequate passage in between for easy retrieval. The cement shall be issued on 'First-In-First-Out' basis.

5.13.4 In case different grades of cement are stored in the same shed, each grade shall be stacked separately to avoid mix up and clear indication boards shall be provided to identify different grades.

5.14 Synthetic Paints

These have limited life and as a safeguard against possible deterioration, the drums shall be inverted at regular intervals as specified to minimise risk of hard settling of pigments.

5.15 Slings & Wire Ropes

All slings and wire ropes shall be coated with approved grease and hung from racks in rolled condition.

6.0 DOCUMENTATION

The CONTRACTOR'S store-keeping function will include maintaining various records as required by the OWNER / CONSULTANT. These records shall include but not be limited to:

6.1 Supplier wise record of equipment / material received stored and issued for erection as well as stock position.

6.2 Record of inspection and repairs carried out, protective measures and lubrication of equipment in storage as well as erected until the same are taken over by the OWNER.

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 SCHEDULE

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:- 1X660 MW PANKI THERMAL POWER STATION EXT.

SEWAGE TREAMENT 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 discrepancy 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 ESTIMATED AUXILIARY POWER CONSUMPTION FOR WORKING DRIVES AT MOTOR INPUT TERMINAL (IN KW) (For complete Sewage Treatment Plant)
		WORKING	STANDBY	
1	Complete Sewage treatment plant (Considering all working drives as per technical specification)			**Vendor to Quote/indicate**
				Total (Kw)

Note-Estimated power consumption (EPC) figure for the system (for working drives only) has been estimated as **46KW**. So long bidder's quoted guaranteed 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 @ 5,84,000/- (Rupees Five lacs and eighty-four thousand per Kilowatt) 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 @ 5,84,000/- (Rupees Five lacs and eighty-four thousand) per additional KW shall be levied on vendor. (+) 1.0% of the guaranteed Auxiliary Power Consumption shall be acceptable shortfall with LD.