HARYANA POWER GENERATION CORPORATION LTD.

1X800 MW ULTRA SUPER CRITICAL EXPANSION UNIT, DEEN BANDHU CHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR

TECHNICAL SPECIFICATION

FOR

VENTILATION SYSTEM

SPECIFICATION NO.: - PE-TS-510-554-A001 (REV-00)
(JULY-2026)

BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
BHEL SADAN
SECTOR-16A, PLOT NO.-25, NOIDA, INDIA

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SECTION - I

SECTION-I

SUB-SECTION-A

INTENT OF SPECIFICATION

1.0 INTENT OF SPECIFICATION

1.1 The specification covers design (i.e. Preparation and submission of drawing /documents including "As Built" drawings and O&M manuals), engineering, manufacture, supply / procurement, inspection and testing at vendor's / sub vendor's / manufacturer's works, painting, maintenance tools & tackles (as applicable), fill of lubricants & consumables till handing over, mandatory spares along with spares for erection, start-up and commissioning as required, forwarding, proper packing and shipment till site, unloading, handling & on-site transportation, storage, preservation , security / safety at site , Erection & Commissioning, final painting at site, minor civil & structural works (as applicable) as required, trial run at site and carrying out Performance guarantee / Functional / Demonstration tests at site (As applicable), training of customer/client O&M staff and handover in flawless condition of the package to the end customer complete with all accessories for the total scope defined as per BHEL NIT & tender technical specification as specified above, amendment & agreements till placement of order for **1X800 MW HPGCL YAMUNA NAGAR STPP-EPC VENTILATION SYSTEM**.

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 the contractor of the responsibility of providing such facilities to complete the supply, erection and commissioning, performance and guarantee/demonstration testing of **VENTILATION SYSTEM**.

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 highest 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 judgement 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. Similarly, the extent of supply also includes all items required for completion of the system and not withstanding that they may have been omitted in drawings / specifications or schedules.

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

1.6 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 Sec-II of the specification **within 10 days of receipt of tender documents.** In absence of any such clarifications, in case of any contradictory requirement, the more stringent requirement as per interpretation of Purchaser / Customer shall prevail and shall be complied by the bidder without any commercial 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 Purchaser/ Customer as and when brought to their notice either by the bidder or by purchaser/ customer themselves. However, such requirements shall be binding on the successful bidder without any commercial & delivery implication.

1.7 The bidder's offer shall not carry any sections like clarification, interpretations and /or assumptions.

1.8 Deviations, if any, should be very clearly brought out clause by clause along with cost of withdrawal in the enclosed schedule (in Vol – III); otherwise, it will be presumed that the vendor's offer is strictly in line with NIT specification. If no cost of withdrawal is given against the deviation, it will be presumed that deviation can be withdrawn without any cost to BHEL/its customer.

1.9 In the event of any conflict between the requirements of two clauses of this specification documents or requirements of different codes and standards specified, Section – C1 shall prevail, however more stringent requirement as per the interpretation of the owner shall apply.

Further, in case of any discrepancy in section 'C1' and section 'C2', Section-C2 shall prevail (customer specification). however more stringent requirement as per the interpretation of the owner shall apply.

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

1.11 For definition of word like Contractor, bidder, supplier, vendor, Customer/ Purchaser Employer, consultant, please refer relevant clause of NIT.

SECTION: I

SUB-SECTION: B

PROJECT INFORMATION WITH WIND & SEISMIC DESIGN CRITERIA AND WATER ANALYSIS

CHAPTER – 2

PROJECT INFORMATION

1.0 BACKGROUND AND SALIENT FEATURES

Introduction

Haryana Power Generation Corporation Ltd (HPGCL) came into existence in August 1998 on unbundling of erstwhile Haryana State Electricity Board into four (4) entities under the reform program.

The State of Haryana is rich in agricultural resources besides a large number of medium and small-scale industries. The Government of Haryana has taken strategic initiatives for development of industrial, commercial and agricultural sector for overall growth in the state. HPGCL is the nodal agency which is responsible for generating power and for coordinating the capacity addition program under the private and public sector in Haryana. HPGCL has proposed a 800 MW coal based thermal power Unit as expansion of 2x300 MW DCRTPP plant at DCRTPP, Yamuna Nagar in the state sector.

Location

The proposed site for this expansion Unit is in the already acquired premises of existing 2x300 MW Units at DCRTPP, Yamuna Nagar.

Type of Plant

The proposed 800 MW Coal Fired Power Unit consists of coal fired steam generator connected to a reheat type steam turbine generator along with all the required auxiliaries.

The description and salient technical data of the Steam Generator, Steam Turbine Generator, Auxiliary systems, Electrical, Control & Instrumentation, Civil etc. are explained elsewhere in the specification:

2.0 PROJECT INFORMATION

1.1	Owner	**HARYANA POWER GENERATION CORPORATION LIMITED, PANCHKULA, HARYANA**	
1.2	Project Title	Deen Bandhu Chhotu Ram Thermal Power Plant (1X800 MW Expansion Unit), Yamuna Nagar	
1.3	Owner's Consultant	**DESEIN PRIVATE LIMITED, NEW DELHI**	
1.4	Project Site Location	Place	Kalanaur
		District	Yamuna Nagar
		State	Haryana
		Country	India
1.5	Latitude & Longitude of project site	North	30^0 06' 34" N
		East	77^0 19' 43" E
1.6	Nearest Railway Station	Kalanaur	2 km

1.7	Nearest Town	Yamuna Nagar	8 km
1.8	Nearest Highway	National Highway - 344	
1.9	Nearest Airport	Chandigarh	110 km
1.10	Nearest Water Body	Western Yamuna Canal, adjacent to site	
1.11	Land	Land is in possession of HPGCL.	
1.12	Station Graded Level Elevation from Mean sea level (MSL)	Land Contour varies from RL Plant FGL 270.00 M Plant FFL 270.50 M	
1.13	Water		
1.13.1	Nearest Water Source	Western Yamuna Canal system running adjacent for project site	
1.13.2	Water Requirement for station	~ 2300 M^3/hr considering closed cooling cycle with NDCT. Additional 750m^3/hr for ash slurry preparation during emergency ash disposal and line flushing	
1.13.3	Raw Water Analysis	Refer Appendix - I	
1.14	Site Ambient Condition	Refer enclosed Climatological Table	
1.14.7	Basic Wind Speed	As per IS 875 latest revision	
		For wind resistance design of structure & equipment refer relevant civil section	
1.14.8	Climatic condition	Refer enclosed Climatological Table	
1.15	Seismic data	Zone – IV as per IS: 1893 latest revision	
		For earthquake resistance design of structure & equipment refer relevant civil section	
1.16	Fuel Data		
1.16.1	Coal Source		
1.16.2	Coal Transportation	Thru BOBR / BOXN wagons of Indian Railways System	
1.16.3	Coal Analysis	Refer Appendix – II	
1.16.4	Support Fuel (LDO) transportation	Support fuel will be transported by road tankers. Start-up/support fuel for the proposed project will be LDO.	
1.16.5	Support Fuel (LDO) analysis	Refer Appendix – III	
1.16.6	Lime stone for FGD	Refer Appendix - IV	

2.0 Access to Site

The nearest town Yamuna Nagar is about 8 km from site. It is easily accessible by Railway/Road.

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

3.0 Plant Rating, Capacity, Availability, PLF

Plant continuous rating will be 800 MW at generator terminals based on the following site conditions.

- Ambient air temperature

- Condenser cooling water inlet temperature of 33°C and 9°C temperature rise across the condenser.
- Generator power factor of 0.85 (zero point eight-five).
- Fuel specification as given in Appendix II & III.
- Design temperature for electrical equipment is 50°C.

The VWO capacity of the steam turbine 800 MW will be 105% or 840 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 800 MW unit will be evacuated over the 400 KV through a 400 KV gas insulated switchyard. Further to Switchyard, distribution will be by others. Interconnection of proposed 400 KV Switchyard with existing 220 kV switchyard shall be done as specified in Volume IV.

5.0 General Information

Land for labour colony, laydown area for storage of equipment, fabrication yard or any other construction related activities is not available within the plant boundary. Bidder has to make his own arrangement to have these facilities outside plant boundary.

Disposal and cleaning of all construction debris inside the plant boundary and facilities of bidder outside plant boundary are included in bidder's scope.

APPENDIX – I

RAW WATER ANALYSIS

(Source - Western Yamuna Canal)

S. No.	Description	Unit	Parameter
1	**Physical characteristics**		
	pH	-	8.45
	Turbidity	NTU	5.7
	Conductivity at 25^0C	μmhos /cm	300
	Total Dissolved solids	Mg/l	220
	Colour	Hazen	<5.0
2	**Cations**		
	Calcium Hardness	mg/l	105
	Magnesium Hardness	mg/l	40
	Sodium (as Na)	mg/l	20
	Potassium (as K)		7
	Iron (as Fe)	mg/l	2
	Total Cations	mg/l	174
3	**Anions**		
	M-alkalinity (as $CaCO_3$)	mg/l	128
	Chlorides (as Cl)	mg/l	15
	Sulphate (as SO_4)	mg/l	26
	Nitrate (as NO_3)	mg/l	6.8
	Total Anions	mg/l	175.8
4	Total Hardness	mg/l	145
5	P-alkalinity	mg/l	3.9
6	Dissolved Silica	mg/l	6.4
7	Colloidal Silica	mg/l	4.2
8	Organic Matter	mg/l	4.8

जलवायवी सारणी
CLIMATOLOGICAL TABLE

स्टेशन : अम्बाला | STATION : Ambala | अक्षांश LAT. 30° 23' | देशांतर LONG. 76° 46' | समुद्री तल माध्य से ऊंचाई HEIGHT ABOVE M.S.L. 272 मीटर METRES | प्रेक्षणों पर आधारित BASED ON OBSERVATIONS 1981-2010

माह / MONTH		स्टेशन का सतह दाब / STATION LEVEL PRESSURE	वायु तापमान / AIR TEMPERATURE										आर्द्रता / HUMIDITY		मेघ की मात्रा / CLOUD AMOUNTS		वर्षा / RAINFALL						
			माध्य / MEAN						चरम / EXTREMES														
			शुष्क बल्ब / DRY BULB	नम बल्ब / WET BULB	दैनिक अधिक तम / DAILY MAX	दैनिक न्यून तम / DAILY MIN	माह में उच्चतम / HIGHEST IN THE MONTH	माह में निम्नतम / LOWEST IN THE MONTH	उच्चतम / HIGHEST	दिनांक और वर्ष / DATE AND YEAR	निम्नतम / LOWEST	दिनांक और वर्ष / DATE AND YEAR	सापेक्ष आर्द्रता / RELATIVE HUMIDITY	वाष्प दाब / VAPOUR PRESSURE	समस्त मेघ / ALL CLOUDS	निम्न मेघ / LOW CLOUDS	मासिक योग / MONTHLY TOTAL	वर्षा के दिनोंकी संख्या / NO. OF RAINY DAYS	वर्षसहित सबसे नम महीने का योग / TOTAL IN WETTEST MONTH WITH YEAR	वर्षसहित शुष्कतम महीने का योग / TOTAL IN DRIEST MONTH WITH YEAR	24 घंटोंकी सबसे भारी वर्षा / HEAVIEST FALL IN 24 HOURS	दिनांक और वर्ष / DATE AND YEAR	माध्य पवन गति / MEAN WIND SPEED
		एच.पी.ए hPa	डि. से °C	डि. से °C	डि. से °C	डि. से °C	डि. से °C	डि. से °C	डि. से °C		डि. से °C		प्रतिशत %	एच.पी.ए hPa	आकाश के अष्टमाश Oktas of sky		मि.मि. mm		मि.मि. mm	मि.मि. mm	मि.मि. mm		कि.मी. प्र. घं. Kmph
जनवरी / JAN	I	984.6	8.6	7.7	18.9	6.4	24.1	2.7	29.1	29	-1.3	24	87	9.9	4.1	2.6	27.3	1.9	152.7	0	118.4	16	3.4
	II	982.8	16.5	12.7						1991		2008	63	11.8	3.1	1.3			1953			1953	
फरवरी / FEB	I	982.2	11.7	10.1	22.4	9.1	27.3	5	33.9	28	-0.6	1	81	11.2	3.1	1.3	35.1	2.2	233.9	0	146.8	11	4.7
	II	980.3	20.2	14.9						1956		1905	54	12.8	3	1.1			1898			1898	
मार्च / MAR	I	979.6	17.5	14.4	27.8	13.8	33	8.9	41.7	31	3.7	9	70	14	2.8	0.9	27.2	1.8	176	0	103.9	13	5.1
	II	977.3	25.6	18						1945		1979	45	14.7	3.1	1.1			1982			1956	
अप्रैल / APR	I	975.8	24.6	18.2	34.9	19.1	40.1	13.7	45	28	9.4	6	51	15.8	2.2	0.6	12.3	1.2	174.4	0	82	6	4.9
	II	973.1	33	20.4						1941		1967	28	14	2.5	0.9			1983			1935	
मई / MAY	I	972.2	29.1	21.6	38.1	23.4	42.6	18	47.8	29	13.9	1	50	19.9	1.8	0.6	31.5	2.7	146.7	0	85.1	20	5
	II	968.9	36.3	23.2						1944		2004	31	18	2	0.9			2008			1913	
जून / JUN	I	968.6	30.1	24.3	38.1	25.4	42.8	20.3	47.8	17	17.8	5	62	25.9	2.9	1.4	86.6	4.5	291.3	0	121.8	20	5
	II	965.1	36.1	25.4						1923		2000	42	23.9	2.6	1.4			1913			1973	
जुलाई / JUL	I	968.3	28.7	26.1	34.4	25.5	38.9	21.8	46.7	10	19.4	5	81	31.8	5.1	2.8	264.7	9.1	715	7.2	206.7	16	4.2
	II	965.5	32.5	27.2						1903		1956	67	31.9	5	3.1			2010	1967		2001	
अगस्त / AUG	I	970.4	28	26	33.3	25	36.3	22.2	43.9	7	3.7	11	84	32.1	5.1	2.8	239.2	9	649	1.7	246.2	3	3.4
	II	967.6	31.4	27.3						1918		2010	72	32.9	5.1	3.3			2004	1993		2004	
सितम्बर / SEP	I	974.5	26.4	24.2	33.1	23	35.7	19.3	40.6	6	15.6	22	82	28.6	3	1.7	134.8	4.8	661	0	224.8	26	3.5
	II	971.6	30.9	25.6						1951		1972	64	28.6	3	1.9			1962			1945	
अक्तूबर / OCT	I	980	21.2	18.5	31.7	17.1	34.6	12.4	39.4	6	8.3	30	76	19.5	0.8	0.3	15.1	0.8	306.5	0	141.6	5	2.6
	II	977.2	28.5	21.5						1941		1898	51	20.1	1	0.4			1955			1973	
नवम्बर / NOV	I	983.6	14.5	12.7	27.1	11.1	30.5	6.6	35.6	14	1.8	29	81	13.5	1.2	0.3	4.5	0.6	136.4	0	135.1	26	2.3
	II	981.1	23	17.2						1947		1966	53	15	1.3	0.2			1951			1951	
दिसम्बर / DEC	I	985.3	9.5	8.5	21.7	7.1	25.5	3.3	29.4	5	-0.6	27	86	10.4	3	1.6	19.7	1	111.2	0	72.5	10	2.5
	II	983.2	18.1	13.8						1944		1913	60	12.4	2.5	0.8			1997			1997	
वार्षिक योग या माध्य ANNUAL TOTAL OR MEAN	I	977.1	20.8	17.7	30.1	17.2	43.5	2.1	47.8	29	-1.3	24	74	19.4	2.9	1.4	898.2	39.6	2047.7	297.6	246.2	3	3.9
	II	974.5	27.7	20.6					5	1944	1	2008	52	19.7	2.9	1.4			1896	1918	8	2004	
वर्षोंकी सं NUMBER OF YEARS	I																						
	II	28	28	28	29	29	29	29	107		107		28	28	28	28	30	30	106	106	108		29

जलवायवी सारणी
CLIMATOLOGICAL TABLE

स्टेशन : अम्बाला
STAION : Ambala

माह	मौसम परिघटना के साथ दिनों की संख्या						पवन														मेघ						दृश्यता			
	वर्षण 0.3 मि.मि.या अधिक						पवन की गति के साथ दिनों की संख्या (कि. मी. प्र. घं.)				पवन की दिशा के दिनों की संख्या का प्रतिशत										मेघ मात्रा (सभी मेघ) सहित दिनों की संख्या - अष्टमांश						निम्न स्तरी मेघ मात्रा सहित दिनों की संख्या - अष्टमांश				दृश्यता सहित दिनों की संख्या			
	WEATHER PHENOMENA						WIND														CLOUD						VISIBILITY			
	No. OF DAYS WITH						No. OF DAYS WITH WIND SPEED (Km. p. h.)				PERCENTAGE No. OF DAYS WIND FROM										No. OF DAYS WITH CLOUD AMOUNT (ALL CLOUDS) OKTAS						No. OF DAYS WITH LOW CLOUD AMOUNT OKTAS				No. OF DAYS WITH VISIBILITY			
महीना	हिम वर्षण 0.5mm Or more	धुंध FOG	तड़ित GRD	कुहासा FOG	धूल भरी आंधी DUST STORM	ओले SOL ALL	62 या अधिक 62 Or more	20-61	1-19	0	3	उ. NE	पू. E	द. SE	द. S	द. प. SW	प. W	उ. प. NW	शांत CALM	0	1-2	3-5	6-7	8	धुंधला 9	0	1-2	3-5	6-7	8	धुंधला 9	1 कि.मी. तक UPTO 1Km.	1-4 कि.मी. 1-4 Kms.	4-10 कि.मी. 4-10 Kms.	10-20 कि.मी. 10-20 Kms.	20 कि.मी. से अधिक MORE THAN 20 Kms.
जनवरी JAN	I	3.3	0.1	1.6	9.6	0.1	0	0	0	12	19	2	0	1	5	0	1	5	22	64	9	3	4	5	10	16	3	4	1	7	0	8.6	15.6	6.8	0	0
	II							0	0	20	11	3	0	1	6	0	0	10	46	34	12	4	6	6	3	21	3	5	1	1	0	1.4	7.7	21.9	0.1	0
फरवरी FEB	I	4	0.3	2.1	1.8	0	0	0	0	14	14	3	1	2	8	1	0	4	29	52	10	4	6	5	3	18	3	5	1	1	0	1.6	12.6	13.9	0	0
	II							0	0	23	5	2	0	1	9	2	2	15	50	19	9	5	6	7	1	17	5	5	1	0	0	0.1	2.4	25.5	0.1	0
मार्च MAR	I	4.4	0.2	3.9	0.2	0.1	0	0	0	18	13	7	1	2	10	1	0	5	33	41	11	5	7	6	2	22	3	5	1	0	0	0.3	6.3	24.3	0	0.1
	II							0	0	26	5	2	1	1	8	3	2	15	53	15	8	7	7	7	2	17	7	6	1	0	0	0	1.3	29.6	0.1	0
अप्रैल APR	I	3.1	0.2	3	0	0.6	0	0	0	18	12	7	1	4	14	1	1	3	28	41	14	5	6	4	1	25	2	3	0	0	0	0	3.4	26.4	0.2	0
	II							0	0	25	5	6	1	2	7	2	2	8	55	17	10	7	7	5	1	18	7	4	1	0	0	0.1	1.9	27.8	0.3	0
मई MAY	I	5	0.2	6.8	0.1	1	0	0	0	21	10	4	1	5	35	2	0	3	17	33	17	4	5	4	1	24	3	4	0	0	0	0.1	5	25.8	0.1	0
	II							0	0	24	7	6	1	2	16	4	2	8	39	22	13	7	6	4	1	19	7	4	1	0	0	0.2	2.8	27.9	0.2	0
जून JUN	I	6.9	0	6.4	0.1	1.1	0	0	0	21	9	6	1	7	33	4	1	4	13	31	13	3	5	6	3	17	4	7	2	0	0	0.1	5.8	24.1	0	0
	II							0	0	24	6	4	1	3	17	4	3	13	36	19	12	6	6	5	1	15	7	7	1	0	0	0.3	3.8	25.8	0.1	0
जुलाई JUL	I	13.2	0	9.4	0	0.3	0	0	0	19	12	2	1	5	38	2	2	3	5	42	3	3	6	13	6	8	4	15	4	0	0	0.1	4.3	26.5	0.1	0
	II							0	0	21	10	4	2	4	21	4	2	11	19	33	2	3	10	14	2	3	7	18	3	0	0	0.1	1.9	28.8	0.3	0
अगस्त AUG	I	13	0	8.6	0.1	0	0	0	0	15	16	2	1	3	27	1	1	6	8	51	3	3	7	12	6	7	6	14	4	0	0	0.1	3	27.8	0.1	0
	II							0	0	19	12	4	1	3	14	3	2	12	20	41	1	3	10	15	2	2	6	21	2	0	0	0	0.6	30.2	0.3	0
सितम्बर SEP	I	7.1	0	4.9	0.4	0.1	0	0	0	14	16	5	1	3	17	1	1	3	15	54	11	4	6	6	3	17	4	7	2	0	0	0.1	4	25.7	0.2	0
	II							0	0	21	9	3	1	1	7	1	2	16	40	29	8	7	8	6	1	10	9	10	1	0	0	0	0.9	29	0.2	0
अक्तूबर OCT	I	1.8	0	1.3	0.4	0.1	0	0	0	9	22	3	1	2	11	1	0	1	10	71	25	2	2	1	1	29	1	1	0	0	0	0.3	11.4	19.3	0	0
	II							0	0	12	19	2	0	1	3	0	1	2	31	60	22	4	3	2	0	26	3	2	0	0	0	0	4	27	0	0
नवम्बर NOV	I	0.9	0	0.8	0.9	0	0	0	0	6	24	1	0	1	4	1	0	1	12	80	20	3	4	2	1	28	1	1	0	0	0	0.9	17.4	11.7	0	0
	II							0	0	9	21	0	0	0	1	0	0	1	26	72	20	4	4	2	0	27	2	1	0	0	0	0	4.3	25.7	0	0
दिसम्बर DEC	I	2	0.2	1.2	6.7	0	0	0	0	7	24	2	1	0	4	0	0	2	16	75	14	3	5	4	5	22	2	3	0	4	0	5.9	19.4	5.7	0	0
	II							0	0	13	18	1	0	0	2	0	0	4	34	59	13	5	6	5	2	22	3	4	1	1	0	0.8	7.4	22.9	0	0
वार्षिक योग या माध्य ANNUAL TOTAL OR MEAN	I	84.7	1.2	50.1	20.3	3.2	0	0	0	170	195	4	1	3	17	1	1	3	17	53	155	43	64	64	39	233	36	67	16	13	0	17.9	106.4	239.9	0.8	0.1
	II							0	1	238	126	3	1	2	9	2	2	10	36	35	129	64	81	75	16	199	66	87	11	2	0	2.8	38.9	321.8	1.5	0
वर्षों की सं. NUMBER OF YEARS	I	29										29									29					29						29				
	II									29					29							29					29									

		Expected Filtered Water Analysis	
S.No.	**Constituent**	**As**	**mg/l**
1.0	Calcium	CaCO3	140
2.0	Magnesium	CaCO3	41
3.0	Sodium	CaCO3	44.48
4.0	Potassium	CaCO3	8.95
5.0	Total Cations	CaCO3	234.18
6.0	Bicarbonates	CaCO3	140.20
7.0	Nitrate	CaCO3	5.480
8.0	Chloride	CaCO3	38
9.0	Sulphate	CaCO3	51
10.0	Total Anions	CaCO3	234
11.0	Dissolved Silica	SiO2	6.4
12.0	Colloidal Silica	SiO2	4.2
13.0	Iron	Fe	0.3
14.0	pH Value	-	8.5
15.0	Turbidity	NTU	2
16.0	Total Suspended Solids	ppm	2
17.0	Total Dissolved Solids	ppm	347
18.0	Organics matter	ppm	0.05
19.0	Conductivity at 25 Deg C (µmhos/cm)		542.180
20.0	Colour (Hazen)		<5.0

SECTION: I

SUB SECTION: C

TECHNICAL SPECIFICATION

SECTION: I

SUB-SECTION: C 1

SPECIAL TECHNICAL REQUIREMENT

1. FUNCTION

The purpose of the system is to provide Ventilation System for different areas of **1x800 MW, YAMUNA NAGAR TPS** under the scope of this tender.

2. SYSTEM DESCRIPTION

2.1. POWER HOUSE

2.1.1 The Ventilation System is provided in the following locations within the Power House by Air washers. Coursing of air in desired direction / areas shall be made by using roof extractors.

TG bay (ground, mezzanine and operating floor), HP/LP heater area, condenser area, Boiler feed pump area Oil cooler area

MCC Rooms.

Cable Spreader Rooms

Switchgear Rooms

Cooled and filtered air from Air Washer Unit shall be distributed by means of ducting to the TG building near various heat sources and after taking the heat load, the hot air from the TG hall shall be exhausted by means of roof extractors and gravity dampers (for cable vault for CCR, cable vault for boiler MCC and boiler MCC room). However, for 220V battery room located at EL 8.5m, exhaust shall be through Wall mounted exhaust fans (spark proof with flame proof motor) and intake through louvers. Fire dampers are provided in the supply air ducting leading to all electrical rooms (MCC, Switchgear etc.).

The quantity of air exhausted shall be kept lower than the quantity of air supplied (70% of total air supplied) in such a way that a little over pressure is maintained inside the Power house. This will reduce infiltration of outside hot and dusty air.

Ventilation system shall comprise of four (4) nos. (all working) Packaged type Air Washers each having capacity of 2,50,000 CMH. Each Air Washer shall be consisting of 2 nos. (2x50%) of fans and 2 nos. (2x100 %) of pumps.

These being packaged type of air washers placed, outside, exposed to ambient, no handling arrangement shall be provided for them.

2.2 ESP CONTROL ROOM BUILDING

2.2.1 The Ventilation System is provided in the following locations (Non-AC area) within the ESP Control room building by Unitary Air Filtration Unit (UAF): -

a. Cable Spreader Rooms
b. Switchgear Rooms

2.2.2 Cooled and filtered air from Unitary Air Filtration Unit (UAF) shall be distributed by means of ducting to the non-AC area of ESP control room building (cable spreader room and switchgear room) and after taking the heat load, the hot air shall be exhausted through

gravity dampers provided in cable vault & switchgear room. Fire dampers are provided in the supply air ducting leading to all electrical rooms (MCC, Switchgear etc.).

2.2.3 The quantity of air exhausted shall be kept lower than the quantity of air supplied (60% of total air supplied) in such a way that a little overpressure is maintained inside the cable and switchgear room. This will reduce infiltration of outside hot and dusty air.

2.2.4 Ventilation system shall comprise of 2 nos. UAF (2X50%), each having capacity of 60,000 CMH for ESP Control room Building. Each UAF shall be consisting of 1 no. (1x100%) of fan and 2 nos. (2x100 %) of pumps.

2.2.5 These being packaged type of UAF placed, outside, exposed to ambient, no handling arrangement shall be provided for them.

2.3. The ventilation philosophy in various areas shall be as under.

S. No.	Area	Type of Ventilation	ACPH
1.	TG Hall	Ventilation with Air washer & mechanical exhaust from Roof Extractor (RE) units.	8
2.	Switchgear room / Cable Vault in TG Building.	Ventilation with Air washer & exhaust through gravity damper.	8
3.	Non-AC areas of ESP control building (Switchgear room / Cable Vault)	Ventilation with UAF & exhaust through gravity damper.	8
5.	CW Pumps House	Supply air through Wall mounted supply fans (with pre-filters) and exhaust air with Exhaust louvers.	20
6.	Fire Water Booster Pump house.	Supply air through Wall mounted supply fans (with pre-filters) and exhaust air with Exhaust louvers.	20
7.	Foam Pump House	Supply air through Wall mounted supply fans (with pre-filters) and exhaust air with Exhaust louvers.	20
8.	Raw Water pump house	Supply air through Wall mounted supply fans (with pre-filters) and exhaust air with Exhaust louvers.	20
9.	MCC / Switchgear room of associated buildings.	Supply air by wall-mounted axial flow fans (with pre-filter & Fine filter) and exhaust through gravity damper.	30
10.	Cable spreader room of associated buildings.	Supply air by wall-mounted axial flow fans (with pre-filter) and exhaust through gravity damper.	30
11.	Battery room	Negative pressurization means of axial flow exhaust having spark proof construction fans with flameproof motors. Supply of air to battery room shall be through intake louvers provided preferably in wall opposite to the exhaust fan. 100% Standby fans shall be provided for battery room.	20

12.	Toilets, pantries.	Mechanical ventilation with propeller type exhaust fan. Supply through undercut / opening below door.	30
13.	CPU Regeneration Building	Fresh air entry through Inlet Louvers and hot air exhaust through Wall Mounted Exhaust Fans.	20
14.	Compressor House	Pressurized ventilation Supply air through Wall mounted supply fans (with pre-filters & fine filters) and exhaust air with gravity operated backdraft dampers.	20
15.	MRS Compressor house	Pressurized ventilation Supply air through Wall mounted supply fans (with pre-filters & fine filters) and exhaust air with gravity operated backdraft dampers.	20
16.	Bunker Bay tripper floor.	Mechanical exhaust by Roof Extractor units and air entry through intake louvers.	20
17.	AC Plant Equipment Areas	Supply air through Wall mounted supply fans (with pre-filters) and exhaust air with gravity operated backdraft dampers.	20
18.	SWAS Room (Non-AC Area)	Supply air by wall-mounted axial flow fans (with pre-filter & Fine filters) and exhaust through gravity damper.	20
19.	Oil rooms including FOPH	Negative pressurization by means of axial flow exhaust fan having spark proof construction fans with flameproof motors. air entry through intake louvers.	30
20.	Gas Cylinder Rooms (Inert gas room, H2/CO2 gas cylinder room)	Wall mounted exhaust fans and air entry through intake louvers.	20
21.	Stores (part of Auxiliary bldgs.)	Mechanical exhaust by means of axial flow exhaust fans.	20

3. DESIGN CRITERIA

Sr. no	System Design Criteria:	System Design Parameters			
1.	The outside design conditions:	(deg C)	Summer	Monsoon	Winter
		DBT	47.8	40.6	29.4
		WBT	23.2	27.3	11.5
		RH (%)	11	36	5
2.	The Inside design conditions:	In evaporative type ventilation area, the inside dry bulb temperature will be 3°C lower than the summer ambient temperature (DB).			

		In dry type forced (mechanical) type ventilation system, the inside temperature shall be restricted about 3°C higher than the summer ambient temperature.
		Air requirement calculated, based on temperature method (where lot of heat is generated) or based on number of air-changes/hr, whichever results in higher air flow rate shall be provided.
3.	Fresh air requirement	ventilation system shall operate on 100% fresh air.
4.	Electric power supply	415V ± 10%, 3 phase, 3-wire, 50 Hz. ± 5% A.C
5.	Equipment design	shall be design for continuous duty.
6.	Specific Features	I. The system shall be design to maintain specified inside design conditions during peak summer under design outdoor condition. II. The ducting, grilles, fans, motors etc. provided for battery rooms shall be painted with acid & fume resistant paint. III. NRD/Gravity dampers shall be provided for each battery room fans. IV. Acid & fume resistance paint shall be applied nearby structure to the exhaust of the fans of the battery rooms as per site requirement.
7.	Saturation efficiency	A. The air washer Unit (AWU) shall have minimum 90% saturation efficiency. B. The Unitary Air Filtration Unit (UAF) shall have minimum 70% saturation efficiency.
8.	Fire dampers	Ventilation ducts shall be provided with motorized type fire dampers at the supply duct in electrical area like MCC / switch gear room/ cable spreader room in Power House and ESP control building which will close in case of fire.
9.	Insulation for duct	Shall be provided for the duct exposed to atmosphere.
10.	Velocity of air in duct	Shall not normally exceed 12.5 m/sec for main duct and 9.5 m/sec for branch duct.
11.	Air Velocity (m/s) through face area (Max.) of different system equipment.	
i-a	Intake/ Suction Louvers for AWU & UAF Unit	2.0 m/s (max.)
i-b	Intake Louvers for Axial fan	2.0 m/s (max.)
ii	Moisture eliminators AWU & UAF Units	2.7 m/s (max.)
iii	Filters for AWU & UAF	2.0 m/s (max.)
iv	Air Pre-filter	2.5 m/s (max.)

v	Air Fine-filter	Not more than 1.2 m/sec for 150 mm and not more than 2.4 m/sec. for 300 mm.	
vi	Supply Air Grills/ Diffusers for Ventilation area	5 m/s (max.)	
vii	Back Draft dampers	7 m/s (max.)	
viii	Volume Control dampers	10 m/s (max.)	
ix	Exhaust Louver	2.7 m/s (max.)	
x	Water piping	2 m/s (max.)	
xi	Water piping gravity flow / pump suction	1.5 m/s (max.)	
11.	Motor design ambient temp	Pump, Roof Exhausters, wall mounted supply & Exhaust Fans, Blowers	50-degree C ambient

3.1 For other details please refer to clauses no 25.4 and other relevant clauses of Customer technical specification section C2-A.

4. LAYOUT CONSIDERATIONS

4.1 A total of 4 Nos packaged type Air washer units (all working) shall be provided for Power House of 1x800 MW. Each air washer with 2x50% duty Centrifugal Fans. The tentative location of these air washers shall be as under.

4.1.1. 2 Nos. Air Washers shall be located outside the TG Hall A- row at roof of "AC plant & MCC for service building and Air Washer" near service building. 2 No Air Washer shall be located in BC Bay at 29.5M between column 3 to 6.

4.1.2. These air washers shall be placed outside, open to atmospheric condition and no masonry room shall be provided.

4.2 2x50% UAF (all working) shall be provided for ESP control room Building. These UAF shall be placed in open at Roof level.

5. EQUIPMENT AND SERVICES TO BE PROVIDED FOR VENTILATION SYSTEM:

Brief scope of supply and services shall be as under:

5.1 Air-washers Units for TG hall:

A	**Packaged type Air washer units (AWU) shall comprises of following.**
1.1	Two (2) no. (2x50% duty) Centrifugal fan backward inclined, DIDW Type, complete with electric drive motor, drive Pulleys, V-belt, belt guards, slide rails and other

	accessories etc.	
1.2	Two (2) nos. nos. (2 x 100 % duty) Horizontal centrifugal / axially split type casing / End suction top discharge horizontal type centrifugal pumps for circulation of water shall be considered. Pump suction shall be provided with pot strainer with by-pass valves, inlet and outlet pressure gauge and filter back wash arrangement.	
1.3	A spray nozzle system consisting of two banks spray system each connected to individual headers, flow regulating valves (Globe valve at Pump outlet) for controlling flow to spray header. The nozzle shall be designed to produce fine atomised spray and shall be properly spaced to give a uniform coverage of the air washer section.	
1.4	• Set of metallic/ fabric filters at suction complete with fixing frame • Distribution plate and moisture eliminators. • Intake louver with frame & Bird screen of GI Construction. • An airtight inspection door of 600 mm x 700 mm size and a water marine light be provided for each air washer tank. • Drain pipe with siphon, marine light in each section.	
1.5	All valves, pipes, nuts & bolts, pipe hangers, supports, internal fittings and supports including ball float valves for makeup water connection with gate valve backup, quick-fill connection with globe valve, drain piping with valve up to the nearest drain point and overflow connection with siphon.	
1.6	No masonry room shall be provided for the air washer units including its accessories. All accessories including centrifugal fans shall be placed inside the AWU sheet metal casing. However, the water circulating pump sets shall be located outside this AWU casing. Air washer chamber shall be provided with adequate stiffness, bracings etc (duly painted with epoxy resin-based paint from inside and outside). Air washer chamber shall be provided with base plate to make the chamber airtight in all respect (closed from all around and bottom).	
1.7	All the dropper lines inside the air washer spray chamber bank shall be provided with end Caps as a part of good engineering practice.	
B	**MOC for Air Washer Unit**	
2.1	Moisture Eliminators plates:	24G thick GS sheets class 275 or 100% virgin PVC die−extruded construction of minimum finished thickness of 2 mm. The eliminator section made of GSS shall have minimum six bends. The PVC eliminators shall be UV stabilised using Titanium di-oxide and shall withstand the weathering test as per IS: 4892 for 500 hours. Type test report of compound testing carried

		out in any reputed laboratory shall be submitted for approval. All supports, tie rods and space bar shall be of either galvanized steel or PVC construction and shall be complete with suitable drip tray & drain pipe.
2.2	Moisture Eliminator Frame:	24 SWG GI sheets and GI angle of adequate strength. The mist eliminator frame shall be located within the tank frame. This shall enable the water drooping down the respective frames directly into the tank, thereby avoiding leakages.
2.3	Intake louver with bird screen	20 G GI Frame and 22 G GI Louvers.
2.4	Distribution plates:	18 G GSS to have 50% free area. The air distribution plate frame shall be located within the tank frame. This shall enable the water drooping down the respective frames directly into the tank, thereby avoiding leakages.
2.5	Water Tank:	Black MS sheet metal of minimum 6mm thick and inside & outside surface of the tank shall be spray galvanized (minimum 60 microns DFT). Min depth –**800mm**. Tank construction shall be such that suction screen can be replaced while the unit is operating. Tank shall be provided with overflow, drain with valve, float valve make-up connection with a gate valve backup, quick fill connection with globe valve etc. The overflow pipe shall be connected to drain pipe after isolating valve on drain pipe. Width of tank of Air washer shall cover complete width of Air washer so that there is no spillage of water and water falling from spray nozzles falls back into the tank. Necessary covering (using GI sheets) on air washer panels besides spray nozzles shall be provided to further stop spillage of water.
2.6	Casing:	Air washer chamber of sheet metal construction with 10 G single skin black MS sheet including base plate (closed from all around and bottom) and various sections shall be bolted through gaskets to avoid leakage of water. The inside & outside of casing shall be protected by spray galvanization. The nuts and bolts used for joining the section shall be galvanized. The connection pieces shall have at least two (2) coats of rust inhibiting paints.
2.7	Piping:	MS Heavy class (Galvanized) to IS: 1239 Part I or IS: 3589 depending on size. Fittings shall be as per IS: 1239 Part-II. Pipes inside air washer spray chamber shall be properly supported using base frame/Flat Foundation of Air Washer. Piping support structure shall be indicated in GA of Air washer. Air release valve shall be provided in air washer piping.

2.8	Suction Screen for Water:	Brass (40 mesh size, 2 nos for each air washer). All the GA drawings of AWU shall include the suction screen chamber with brass type filters/screen.
2.9	Spray nozzles	Nozzles shall be of brass or bronze with chrome plating and self-cleaning type, pressure drop across nozzle shall be 1.4 - 2.4 Kg./sq.cm. Uniform distribution of water through each spray nozzle shall be ensured in the Air washer spray section. Difference in pressure in spray nozzles due to head difference shall be corrected by using different sizes of nozzles/pipe size adjustment suitably.
2.10	General	PID of Air washer unit attached elsewhere in the technical specification.

5.1.2 For other details please refer to clauses no 25.6.1 and other relevant clauses of Customer technical specification section C2-A.

5.2 Unitary Air Filtration Units for ESP control room building:

A	**Unitary Air Filtration Units (UAF) shall comprises of following.**
1.1	One (1) no. (1x100% duty) Centrifugal fan backward inclined, SISW Type, complete with electric drive motor, drive Pulleys, V-belt, belt guards, slide rails and other accessories etc.
1.2	Two (2) nos. nos. (2 x 100 % duty) Mono Block type pump for circulation of water shall be considered. Pump suction shall be provided with pot strainer with by-pass valves, inlet and outlet pressure gauge and filter back wash arrangement.
1.3	A spray nozzle system consisting of single banks spray system connected to headers, flow regulating valves (Globe valve at Pump outlet) for controlling flow to spray header. The nozzle shall be designed to produce fine atomised spray and shall be properly spaced to give a uniform coverage of the UAF section.
1.4	• Water repellent type filters complete with fixing frame • Distribution plate and moisture eliminators. • Intake louver with frame & Bird screen of GI Construction. • Inspection door (600 mm x 700 mm) and marine lights with ladder for different section and cat walks as required. An airtight inspection door of 600 mm x 700 mm size and a water marine light be provided for each air washer tank. • Drain pipe with siphon, marine light in each section.

1.5	All valves, pipes, nuts & bolts, pipe hangers, supports, internal fittings and supports including ball float valves for makeup water connection with gate valve backup, quick-fill connection with globe valve, drain piping with valve up to the nearest drain point and overflow connection with siphon.	
1.6	No masonry room shall be provided for the Unitary air filtration units including its accessories. All accessories shall be placed inside the UAF sheet metal casing. However, the SISW type centrifugal fans and water circulating pump sets shall be located outside the UAF casing. UAF chamber shall be provided with adequate stiffness, bracings etc (duly painted with epoxy resin-based paint from inside and outside).	
1.7	All the dropper lines inside the UAF spray chamber bank shall be provided with end Caps as a part of good engineering practice.	
B	**MOC for Unitary Air Filtration Unit**	
2.1	Moisture Eliminators plates:	24G thick GS sheets class 275 or 100% virgin PVC die−extruded construction of minimum finished thickness of 2 mm. The eliminator section made of GSS shall have minimum six bends. The PVC eliminators shall be UV stabilised using Titanium di-oxide and shall withstand the weathering test as per IS: 4892 for 500 hours. Type test report of compound testing carried out in any reputed laboratory shall be submitted for approval. All supports, tie rods and space bar shall be of either galvanized steel or PVC construction and shall be complete with suitable drip tray & drain pipe.
2.2	Moisture Eliminator Frame:	24 SWG GI sheets and GI angle of adequate strength. The mist eliminator frame shall be located within the tank frame. This shall enable the water drooping down the respective frames directly into the tank, thereby avoiding leakages.
2.3	Intake louver with bird screen	20 G GI Frame and 22 G GI Louvers.
2.4	Distribution plates:	18 G GSS to have 50% free area. The air distribution plate frame shall be located within the tank frame. This shall enable the water drooping down the respective frames directly into the tank, thereby avoiding leakages.
2.5	Water Tank:	Black MS sheet metal of minimum 6mm thick and inside & outside surface of the tank shall be spray galvanized (minimum 60 microns DFT). Min depth −**600mm**. Tank construction shall be such that suction screen can be replaced while the unit is operating. Tank shall be provided with overflow, drain with valve, float valve make up connection with a gate valve backup, quick fill connection with

		globe valve etc. The overflow pipe shall be connected to drain pipe after isolating valve on drain pipe. Width of tank of UAF Unit shall cover complete width of UAF so that there is no spillage of water and water falling from spray nozzles falls back into the tank. Necessary covering (using GI sheets) on UAF panels besides spray nozzles shall be provided to further stop spillage of water.
2.6	Casing:	UAF chamber of sheet metal construction with 10 G single skin black MS sheet (thickness of MS sheet shall be min. 3.15mm) and various sections shall be bolted through gaskets to avoid leakage of water. The inside & outside of casing shall be protected by spray galvanization. The nuts and bolts used for joining the section shall be galvanized. The connection pieces shall have at least two (2) coats of rust inhibiting paints.
2.7	Piping:	MS Heavy class (Galvanized) to IS: 1239 Part I or IS: 3589 depending on size. Fittings shall be as per IS: 1239 Part-II. Pipes inside UAF spray chamber shall be properly supported using base frame/Flat Foundation of UAF. Piping support structure shall be indicated in GA of UAF. Air release valve shall be provided in UAF piping.
2.8	Suction Screen for Water:	Brass (40 mesh size, 1 no for each UAF). All the GA drawings of UAF shall include the suction screen chamber with brass type filters/screen.
2.9	Spray nozzles	Nozzles shall be of brass or bronze with chrome plating and self-cleaning type, pressure drop across nozzle shall be 1.4 - 2.4 Kg./sq.cm. Uniform distribution of water through each spray nozzle shall be ensured in the UAF spray section. Difference in pressure in spray nozzles due to head difference shall be corrected by using different sizes of nozzles/pipe size adjustment suitably.
2.10	General	Please refer PID of UAF unit attached elsewhere in the technical specification.

5.2.1 For other details please refer to clauses no 25.6.2 and other relevant clauses of Customer technical specification section C2-A.

5.3 Centrifugal flow fan units

A	Each centrifugal fan shall be complete with
1.1	Fan impeller (backward curved) with casing & supports
1.2	Electric drive motor
1.3	Drive Pulleys, V–belt, belt guards, slide rails etc.

1.4	Dampers and flexible connection with matching flanges.	
1.5	Vibration isolators, foundation bolts and nuts.	
B	MOC for Centrifugal fan	
2.1	Fan Scroll:	Heavy Gauge MS (IS−2062 Gr.B) with Galvanized.
2.2	Fan Casing (side plates & stiffeners):	Casing shall be of welded construction fabricated with heavy gauge galvanized sheet steel or MS sheet with spray galvanization (minimum 60-micron DFT). The minimum thickness of casing shall be 3mm. It shall be rigidly reinforced and supported by structural angles. The seams shall be permanently sealed air tight.
2.3	Impeller:	M.S. sheet/plate (IS−2062 Gr.B)
2.4	Impeller hub:	Mild Steel
2.5	Impeller back plate blade & shroud:	Mild Steel to IS: 2062 Gr.B.
2.6	Shaft:	EN − 8 or eqv.
2.7	Fan Supports, frames and structure:	Mild Steel (IS−2062 Gr.B)
2.8	Flexible connection at outlet/inlet:	Fire resistant type plastic impregnated canvas with M.S. flange and cleats (3 mm thick).
2.9	V Belt (matched sets):	ISI marked (Reinforced rubber section to (IS: 4776)
2.10	V Pulley:	Cast Iron multi−groove to Gr−20 as per IS: 210.
2.11	Slide rails:	M.S. / C.I.
2.12	Connection pieces:	G.I. according to supplier's design.
2.13	Bolts & nuts:	Galvanized / MS (Epoxy painted).
2.14	Accessories	Vibration isolating cushy foot mountings (70% efficiency), foundation bolts and nuts etc.
2.15	Dampers:	Heavy Gauge MS (IS−2062 Gr. B).

5.3.1 For other details please refer to clauses no 25.6.3 and other relevant clauses of Customer technical specification section C2-A.

5.4 Wall mounted axial flow fan

A	Each wall mounted axial flow fan shall be complete with
1.1	Fan impeller & casing/ short duct as required.
1.2	Electric drive motor with coupling if any, including motor brackets.

1.3	Inlet cone and grouting framework, if any.	
1.4	Rain protection cowl with bird−screen.	
1.5	All supply air axial flow fans shall be provided with pre−filters (and also fine filters for MCC/ switchgear room).	
1.6	The speed of the fan shall not exceed 960 rpm for fan with impeller diameter above 450 mm and 1400 rpm for fan with impeller diameter 450 mm or less. However, for fans having static pressure of 30 MMWC or above the speed of the fan shall not exceed 1440 rpm for fan with impeller diameter of above 450 mm and 2800 rpm for fan with impeller diameter of 450 mm or less. The first critical speed of rotating assembly shall be at least 25% above the operating speed.	
1.7	Adjustable damper, vibration isolators, back draft dampers etc, if any.	
B	MOC for Axial fan	
2.1	Casing:	M.S. sheet – 3 mm thk for fan dia upto 750 mm, 5mm thick for fan dia of 750 mm and above as per IS:1079 / IS:2062 Gr.B
2.2	Impeller:	Cast Aluminium. (Alloy A−6M, IS−617)
2.3	Hub:	As per manufacturer std. (AL− LM6)
2.4	Support frame and structure:	M.S. of adequate thickness (Galvanized / painted) IS−2062 Gr.B.
2.5	Vibration isolator (As required)	Neoprene rubber pads
2.6	Coned inlet for wall exhausters / supply fans:	MS (IS−2062 Gr.B)
2.7	Supporting frame for mounting:	Required.
2.8	Protective screen at inlet:	Yes (Min 14 SWG Galvanized wire knitted in 1" square mesh).
2.9	Rain Protection Cowl:	Aluminium or GI
2.10	Mounting flange on casing:	At inlet and outlet.
2.11	Painting / protecting coating	MS parts shall be galvanised or epoxy painted.
2.12	Adjustable damper, back draft dampers	GI

5.4.1 For other details please refer to clauses no 25.6.4 and other relevant clauses of Customer technical specification section C2-A.

5.5 Roof Extractor unit

A	Each roof extractor unit shall be complete with

1.1	Fan wheel, electric drive motor with motor coupling if any and motor bracket.	
1.2	Short duct mounting/axial fan casing having inspection door and base.	
1.3	Grouting framework & foundation bolts including screen at bottom.	
1.4	Rain protection cowl with bird−screen (provided with roof – hood with limit switch). All accessories rain protection exhaust hood, transformation piece, vibration isolators, steel support vibration isolators, bird screen, etc as required shall be provided.	
1.5	The speed of the roof ventilators shall not exceed 960 rpm for impeller diameters larger than 450 mm and 1440 rpm for impeller diameters 450 mm and less. However, for fans having static pressure of 30 MMWC or above the speed of the fan shall not exceed 1440 rpm for fan with impeller diameter of above 450 mm and 2800 rpm for fan with impeller diameter of 450 mm or less. The first critical speed of rotating assembly shall be at least 25% above the operating speed.	
1.6	The vibration level of fans shall be as per ISO: 14694.	
B	MOC for Roof Extractor Unit	
2.1	Casing/ cowl/ hood:	(Spray / hot galvanized M.S. Sheet to IS: 2062 Gr.B (Short duct casing). Casing thickness: 3 mm thk for fan dia upto 750 mm, 5mm thick for fan dia of 750 mm and above. In casing, access door with locking arrangement shall be provided. The cowl shall be designed for weather protection of the fan also inside the roof on which the extractor is installed. Galvanized bird screen of 15 mm square be provided with the cowl. All accessories, steel supports as required will be provided.
2.2	Impeller:	Cast Aluminum alloy to A−6M, IS−617.
2.3	Support frame and structure:	M.S of adequate thickness (IS−2062 Gr.B).

5.5.1 For other details please refer to clauses no 25.6.5 and other relevant clauses of Customer technical specification section C2-A.

5.6 Water Pump Sets

A	Each circulating water pump set for air washer shall comprise of the following
1.1	Centrifugal pump Back Pull out type Horizontal centrifugal / axially split type casing / End suction top discharge horizontal type centrifugal pumps of adequate capacity to match the system requirement for Air washer & Mono Block type Centrifugal Pump of adequate capacity to match the system requirement for UAF.

1.2	One no. adequately sized TEFC sq. cage induction motor suitable for 415V, 3 phase, 50 Hz AC supply	
1.3	One no. Pot type strainer at inlet complete with screen, drain arrangement etc.	
1.4	150 mm dia. Dial Type pressure gauges one each at discharge side of the pump set.	
1.5	Butterfly valve, one each at suction and Globe valve, one each at discharge side of the pump set.	
1.6	One no. non−return (check) valve at discharge side of each pump set.	
1.7	One set of base plate, coupling, coupling guard, anti−vibration mountings, foundation bolts etc.	
1.8	Speed of Pump shall be 1500 RPM (Max)	
B	MOC for Water Pump Set	
2.1	Casing:	2% Ni Cast iron to IS: 210 GR. FG−260.
2.2	Impeller:	SS CF 8M
2.3	Wearing ring:	Bronze Grade IS: 318 GR−2.
2.4	Pump shaft:	SS 410
2.5	Shaft Sleeve:	SS 316.
2.6	Lantern ring	Brass / Bronze
2.7	Packing	Asbestos free
2.8	Base plate:	Carbon steel as per the IS−2062 Gr.B.
2.9	Bolt and nuts:	M.S. (Epoxy painted / Galvanised).
2.10	Type of seal:	Mechanical
2.11	Pump motor coupling:	Pin & bush type.

5.6.1 For other details please refer to clauses no 25.7.9 and other relevant clauses of Customer technical specification section C2-A.

5.7 Air Filters

A	**PRE-FILTER**	
1.1	Filter Media:	**Fabric filter:** Washable non-woven synthetic fibre or high density Polyetylene (HDPE) media. The

		filter media shall be supported with HDPE mesh on air inlet side & Aluminium expanded metal on exit side or GI wire mesh on both sides. **Metallic Filter:** SS mesh filter **UAF:** Water repellent nylon type.
1.2	Frame Work	18 G GSS conforming to IS:277 / 16G Al conforming to IS:737 alloy. Filter mounting frame shall be GI angle iron frame of adequate thickness.
1.3	Size & type	610 x 610 mm (Approx.) & Flange / Cassette
1.4	Filter Thickness	Min. 50 mm
1.5	End sealing	Epoxy Adhesive/ neoprene sponge rubber
1.6	Testing standard	BS:6540/ASHRAE – 52 – 76/ EN-779.
1.7	Average synthetic dust wt. arrestance Efficiency: (Equivalent Efficiency)	65 – 80% (90% down to 10 microns).
1.8	Allowable pressure drops:	Initial press drop – Not to exceed 5.0 mm WC at rated flow. Final press. drops– Up to 7.5 mm WC.
1.9	Location:	a. At discharge of each supply air fan. b. At suction of air washer (Fabric / metallic type) c. UAF (Water repellent nylon type)
1.10	Other requirements (as applicable):	
	1. Suitable aluminium spacers be provided for uniform air flow; 2. Casing shall be provided with neoprene sponge rubber sealing 3. Capable of being cleaned by water flushing. 4. Density of filter medium shall increase in the direction of air flow in case of metallic filter. 5. Filter media shall be fire retardant and resistant to moisture, fungi, bacteria & frost.	
B	**FINE-FILTER**	
1.1	Filter Media:	Washable non-woven synthetic fibre or high density Polyetylene (HDPE) media. The filter media shall be supported with HDPE mesh on air inlet side & Aluminium expanded metal on exit side or GI wire mesh on both sides. The filter media shall be supported with HDPE mesh on air inlet side &

		Aluminium expanded metal on exit side or GI wire mesh on both sides.
1.2	Frame Work	18 G GSS conforming to IS:277 / 16G Al conforming to IS:737 alloy. Filter mounting frame shall be GI angle iron frame of adequate thickness.
1.3	Size & type	610 x 610 mm (Approx.) & Flange / Cassette
1.4	Filter Thickness	Min. 150 mm or 300 mm
1.5	End sealing	Epoxy Adhesive/ neoprene sponge rubber
1.6	Testing standard	BS:6540/ASHRAE – 52 – 76/ EN-779.
1.7	Average synthetic dust wt. arrestance Efficiency: (Equivalent Efficiency)	> 90% (95% down to 5 microns).
1.8	Allowable pressure drops:	Initial pressure drop - Not to exceed 10 mm WC at rated flow, Final pressure drop-Up to 25 mm WC.
1.9	Location:	a. At the discharge of each supply air fan having static pressure of 30 mm WC or more.
1.10	Other requirements (as applicable):	
	1. A neoprene sponge rubber sealing shall be provided on either face of the filter frame. 2. Capable of being cleaned by air or water flushing. 3. Filter media shall be fire retardant and resistant to moisture, fungi, bacteria & frost	

5.7.1 For other details please refer to clauses no 25.7.10 and other relevant clauses of Customer technical specification section C2-A.

5.8 Valves

A	Valves shall comprise followings
1.1	Valves shall have full sizes port and suitable for horizontal and as well as vertical installation.
1.2	Valves for regulating duty shall be of globe type suitable for controlling throughout its lift.
1.3	Gate, Globe and stop check valves shall have bonnet back seat to facilitate easy replacement of packing with the valves in service.

1.4	All safety / relief valves shall be so constructed that the failure of any part does not obstruct the free discharge.
1.5	Manual gear operators be provided for valves of size 200 NB and above.
1.6	All valves shall be provided with locking arrangement.
1.7	All water line valves of size 75 NB & above shall be of cast iron body with internal parts of SS 410 and EPDM / nitrile seat with flanged ends conforming to IS: 780 and valve sizes 65 NB & below shall be of Gun metal / cast iron construction conforming to IS: 778. Cast iron parts shall conform to IS: 210 Gr. FG 220.

5.8.1 For other details please refer to clauses no 25.7.16 and other relevant clauses of Customer technical specification section C2-A.

5.9 Sheet Metal work

A	Sheet metal work shall be designed as under.	
1.1	GSS supply air ducting (as per IS 655) fabricated with GSS sheet (as per IS 277) having zinc coating of 275 g/sqm. The ducting shall be complete with of accessories such as vanes, splitters, dampers, hangers, supports, anchor bolts, sealing components, gaskets etc.	
1.2	Equal Friction method shall be employed for duct sizing. Duct may be site fabricated or factory fabricated and installed at site.	
1.3	The ductwork shall be properly reinforced to prevent sagging, buckling or vibration. Interior of all ducts shall be smooth and free from obstruction. All duct sections shall be cross-broken. All longitudinal joints for the ducts shall be Pittsburgh Lock seam type.	
1.4	The thickness of rectangular ducts shall be as follows.	
Sr.No.	**Larger dimensions of Duct, mm**	**Thickness of GI sheet (mm)**
a.	Up-to 750	0.63 (24 G)
b.	751 to 1500	0.80 (22 G)
c.	1501 to 2250	1.00 (20 G)
d.	2251 & above	1.25 (18 G)

1.5	Transverse joints of the low-pressure ducting shall be continuous around the four sides, the corner closures, as required.
1.6	All ducting work includes:
1.6.1	G. I. Duct having zinc deposition of at least 275 gm/m².
1.6.2	Volume control dampers inside duct with control arrangement at each branch off and wherever necessary. Thickness of VCD shall be minimum 20 G GI sheet.
1.6.3	Thickness of Splitter and dampers shall be made from 16 gauge GS sheet and thickness of louvers shall be of minimum 22 gauge GI sheet.
1.6.4	Flexible connections of rubberized canvas.
1.6.5	Sealing compound and jointing gasket for ducts
1.6.6	Motorized fire dampers (spring return type) shall be provided in the supply & return air duct which shall close and stop the air flow in the event of fire. These dampers shall be operated with the help of a signal from smoke detectors/thermal sensors. The dampers shall operate on “De-energized to close “mode. In the event of fire, the dampers shall close automatically & UAF / Air washer fan shall also stop. Necessary interlocks shall be provided for this purpose in IO panel / DCS control system. Fire damper shall be of rating 90 minute (min.).
1.6.7	MS grilles & diffuser. The diffuser / grills shall be of powder coated MS sheet (20 SWG) for ventilation system.
1.6.8	For Battery room areas, where exhaust ducting is required for ventilation, MS ducting having epoxy coating shall be provided.
1.6.9	Supports and hangers including anchor bolts as required. Duct with larger side greater than 2250 mm shall be supported by 16mm MS rods and 50x50x3 mm MS double Angles while those below 2250 mm shall be supported by 10mm MS Rods and40x40x3 MS angles. The duct supports shall be at a distance of not more than 2000 mm for Ventilation system. In addition to conventional duct support, wire rope support may also be accepted for supporting duct on account of speedy erection, flexibility in adjustment and good aesthetic view.

5.9.1 For other details please refer to clauses no 25.7.13 and other relevant clauses of Customer technical specification section C2-A.

5.10 Thermal Insulation

A	Thermal insulation shall be as under.				
1.1	Thermal insulation shall be provided for the Ventilation duct which is exposed to sun / rain only. Insulation material shall be Resin bonded glass wool conforming to IS: 8183. Density of insulation shall be 24 Kg/m3 and thermal conductivity shall be 0.049 w/m/Deg C at 50 Deg C.				
1.2	Type of insulation & Finish				
S.No	**Surface**	**Insulation Material**	**Insulation Form**	**Thickness (mm)**	**Finish**
a.	Ventilation duct running in AC areas	Resin bonded glass wool or	Roll/ Slab Sheet	50	F-3
b.		Al finished closed cell elastomeric Nitrile rubber		19	No separate finish required
c.	Exposed air duct	Resin bonded glass wool	Roll	50	F-4
1.3	**Finish F-3**				
a.	Step – 1: Insulation shall be covered with 500 g polythene with 50 mm overlap and sealing of overlap with synthetic adhesive like CPRX or equivalent compound.				
b.	Step – 2: The polythene shall be covered with 30-gauge Aluminium sheet and locking of joints with self-locking screws at a pitch of minimum 100 mm.				
1.4	**Finish F-4**				
a.	Step – 1: Insulation shall be covered with 500 g polythene with 50 mm overlap and sealing of overlap with synthetic adhesive like CPRX or equivalent compound.				
b.	Step – 2: Application of 3 mm thk coat of water proofing compound “SHALIKOTE 30” or equivalent and wrapped with fibre glass RP tissue followed by final coat of 3 mm thk water proofing compound “SHALIKOTE 30” or equivalent over thr RP tissue.				
c.	Step – 3 After the above treatment, 22G Aluminium sheet cladding, properly stitched at all joints shall be provided over the external surface.				

5.10.1 For other details please refer to clauses no 25.7.14 and other relevant clauses of Customer technical specification section C2-A.

5.11 ONLINE NON-CHEMICAL TYPE SCALE PREVENTER

A	Non-Chemical type Scale Preventer shall be designed as under.
1.1	Online non-chemical type scale inhibitor/preventer shall be provided at header of cooling tower to avoid formation of scale in condenser water circuit.

1.2	The unit shall be a non-chemical on-line type scale preventer not requiring any chemicals.
1.3	Non-chemical water treatment system shall prevent the formation of hard scale in cooling circuits of air conditioning equipment.
1.4	The size of the unit shall be determined based on the water quality and water flow rate.
1.5	The outer casing shall be of stainless steel.

5.11.1 For other details please refer to clauses no 25.7.12 and other relevant clauses of Customer technical specification section C2-A.

6.0 SPECIFIC FEATURES: -

6.1 RE / wall mounted fans shall be selected so as to have motor rating and wall / slab opening as under. Feeder suitable for following ratings only shall be provided by BHEL.

1.	Roof extractor units with 15 mmwc static pressure.		
	Capacity	Motor rating	Roof / Slab opening
a.	50,000 CMH	5.5 KW	1320mm
b.	40,000 CMH	5.5 KW	1320mm
c.	20,000 CMH	2.2 KW	1140mm
2	Axial flow supply fans with 30 mmwc static pressure.		
	Capacity	Motor rating	Wall opening
a.	10,000 CMH	2.2 KW	800mmx800mm
b.	7,500 CMH	1.5 KW	700mmx700mm
c.	6,000 CMH	1.1 KW	600mmx600mm
d.	4,000 CMH	0.75 KW	500mmx500mm
3	Axial flow supply fans with 20 mmwc static pressure.		
	Capacity	Motor rating	Wall opening
a.	10,000 CMH	1.5 KW	800mmx800mm
b.	7,500 CMH	1.1 KW	700mmx700mm

c.	6,000 CMH	1.1 KW	600mmx600mm
d.	4,000 CMH	0.75 KW	600mmx600mm
4	Axial flow exhaust fans (Bifurcated type) with 15 mmwc static pressure.		
	Capacity	Motor rating	Wall opening
a.	15,000 CMH	2.2 KW	900mmx900mm
b.	10,000 CMH	1.5 KW	800mmx800mm
c.	7,500 CMH	1.1 KW	700mmx700mm
d.	4,000 CMH	0.55 KW	500mmx500mm
E.	2,000 CMH	0.55 KW	500mmx500mm
5	Axial flow exhaust fans with 10 mmwc static pressure.		
	Capacity	Motor rating	Wall opening
a.	15,000 CMH	1.1 KW	900mmx900mm
b.	10,000 CMH	0.75 KW	800mmx800mm
c.	7,500 CMH	0.55 KW	700mmx700mm
d.	6,000 CMH	0.55 KW	600mmx600mm
e.	4,000 CMH	0.55 KW	500mmx500mm
e.	2,000 CMH	0.37 KW	500mmx500mm
6	Exhaust fan (propeller type) with 5 mmwc static pressure.		
	Capacity	Motor rating	Wall opening
a.	1000 CMH	100	330 mm circular

7.0 CONTROL PHILOSOPHY

The Control system shall comprise of DDCMIS for Ventilation system, with remote I/O panel, hook-up with main plant DDCMIS for monitoring only.

7.1 Following Annunciations shall be provided for Air-washers and UAFs.

a) Air washer/ UAF units shall be started/ stopped by initiation from OWS provided in control room of air conditioning. Starting/ stopping of pumps shall be automatic upon such initiation.

b) The operation of pumps shall be interlocked with the low level of water in the sump. High level of the sump shall be annunciated. The stand-by pump shall be started automatically when the working pump is stopped/ tripped.

c) High level of pressure drop across the strainer shall be annunciate.

7.2 Other Controls – Ventilation System

a) Emergency stop push button shall be provided for all drives (pump & fans) for air washer Unit & UAF Unit. All other drives associated with ventilation system like supply fans, exhaust fans, roof extractor etc. shall be fed from respective MCC.

b) Supply air fans, exhaust air fans / roof extractor units of each area shall be provided with their local starter panel.

7.3 For other details please refer to clauses no 25.9 and other relevant clauses of Customer technical specification section C2-A & sub-section C4 TECHNICAL SPECIFICATION (C&I PORTION).

8.0. Terminal Points, Ducting Interface, and Performance Testing

8.1 Terminal Points:

Terminal Points shall be till flange of NRD (Non-Return Damper) of the Ventilation equipment. (Air Washer/UAF). Final Connection of the high side equipment with the ducting system shall be in the scope of bidder.

8.2 Ducting System (Design & Approval):

The design, engineering, and drawing submission for approval from the end customer Ventilation System along with the entire ducting system & associated accessories shall be in the scope of the bidder.

8.3 Duct Leak/Smoke Test:

The Leak Test / Smoke Test required to establish a leak-proof ducting system shall be conducted by the Low side /Duct System Supplier. However, the bidder shall supervise and certify the execution of such tests to ensure that the ducting system performance meets the technical requirements.

8.4 Performance Guarantee (PG) Test:

The Performance Guarantee (PG) Test for the entire Ventilation System (including ducting & accessories) shall be carried out by the bidder as per approved procedures to meet performance parameters as per the specification.

9. General

9.1 Basis of design all calculations including heat load calculations for summer seasons, equipment selection criterion, layout drawings/ schemes/G.A. dwg and documents like data sheet/ technical particulars etc are subject to Customer approval during detail engineering stage.

9.2 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. BHEL shall also not entertain any cost implication for any lack of input data with regard to site during detail engineering.

9.3 All drawings and documents shall be computer based.

9.4 All commissioning spares & consumables for trouble free operation until handing over of the system shall be provided.

9.5 The bidder shall be responsible for providing necessary storage facilities for materials supplied.

9.6 Quality Requirements in the Technical Specification are indicating minimum requirements for inspection and testing. Vendor shall note that quality plan is subject to Customer & BHEL approval during detail engineering stage.

9.7 The drawings/ documents submitted by vendor shall be complete in all respects with revised drawing submitted incorporating all comments. Any incomplete drawing submitted shall be treated as non- submission with delays attributable to vendor's account. For any clarification/discussion required to complete the drawings, the bidder shall himself depute his personal to BHEL / Customer's place any number of time as per the requirement for across the table discussions/ finalizations/ submissions of drawings.

10.0 SCOPE OF SERVICES

Scope of services by bidder will include but not necessarily limited to the following:

10.1 Unloading, Storage, handling and transportation at site.

10.2 Erection & Commissioning of Ventilation System.

10.3 Necessary supports and structures / frames etc. as required for supporting the duct / piping /equipment etc. as lump-sum basis is in the scope of Vendor and no unit rates shall be applicable for these items.

10.4 Minor civil work like chipping of foundation, grouting below base plate for all structures, equipment, grouting of anchor bolts wherever these are not placed in the foundation during casting of foundation itself including special type of grouting like GPX2 etc, making opening to suit / finishing of opening after completion of Ventilation Equipment erection, sealing of duct / pipe opening.

10.5 Making Good / Repairing / replacement of and damaged done by bidder to adjacent structure, pipes etc. while erecting equipment's related to Ventilation System.

10.6 Drain piping up to the drain point to be provided by the Vendor.

10.7 Pre-Commissioning work such as flushing, hydraulic testing etc. Necessary consumables and instrumentation like refrigerant, grease, lubricants, anemometer, tachometer, ammeter, voltmeter etc. for inspection and testing at works as well as at site including pre-commissioning activities shall be arranged by the successful bidder at their own cost.

10.8 Inspection & testing, Performance Requirements and Performance Guarantees as per the specification.

10.9 Painting of equipment's, valves, pipes and other accessories within scope of supply.

10.10 Electrical scope as per enclosure elsewhere in the specification.

10.11 Training of plant Owner's personnel O&M operators' personnel on plant operation and maintenance as per Customer specification.

10.12 Relevant requirements as per GTR, GCC & SCC.

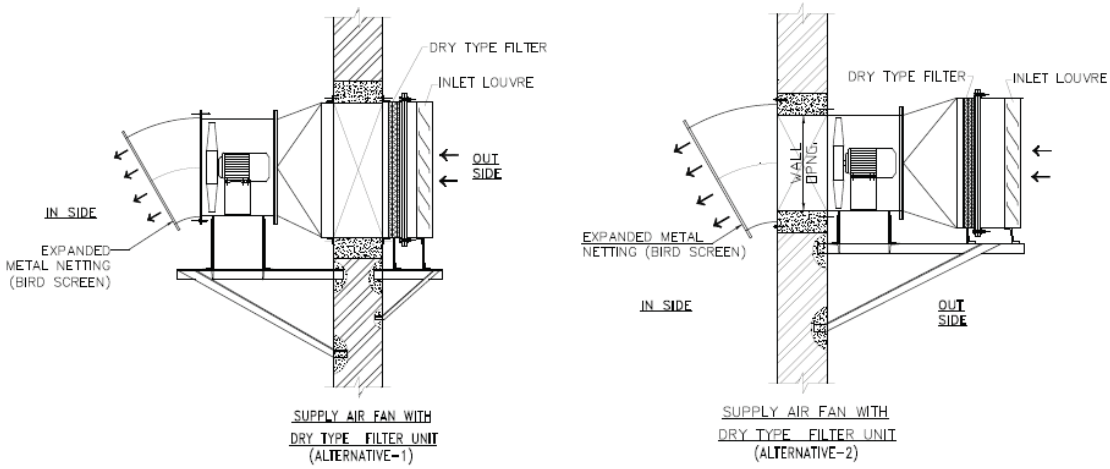
10.13 Any other service required for making the installation complete in all respect within battery limits and for satisfactory erection & commissioning of the system as well as to meet any statutory requirement relevant to the package, unless specifically EXCLUDED from scope of services.

10.14 For motorized fire damper / 3 Way valve actuators / motorized valves, power supply shall be derived by vendor from respective control panels. Suitable transformer shall be provided by

bidder (if required) to derive the power input. Further distribution through junction box / distribution board shall be in vendor scope and shall have provision for isolation of individual fire damper/ valves.

10.15 Bidder should suitably group the signals coming from various instruments etc. & the same shall terminate in local JB, from Local JB common cable to DCS / panel / MCC shall be selected. Any Electrical / C&I items and accessories like junction box, glands etc. shall be included by vendor in his scope.

10.16 Supports required for supporting the fan and/or filter section for Axial fans shall be under bidder's scope.



10.17 All VVFD drives shall be provided with enclosure.

10.18 3 phase 3 wire supply shall be provided for the equipment's. Any requirement of single-phase power supply for the internal operation of the equipment shall be derived internally by the equipment supplier.

10.19 Local push button station shall be provided for local operation of the Air Washer Unit (AWU) and Unitary Air Filter (UAF). In case multiple AWU or UAF are kept in a room or in vicinity, common Local Push Button Station shall be provided for local operation of all the UAF / AWU in the room or located in vicinity.

11.0 Operation services & consumables

11.1 Commissioning of various Ventilation Equipment's under scope of this tender is expected in phased manner depending upon front availability and other site conditions. Bidder shall include in their scope operation of such Ventilation equipment's which are commissioned, until final handing over of complete system to customer. Consumables lube oils, belts, etc. during this period of operation shall also be considered by bidder in their scope. Any shortcoming in the System which may have happened during the operation of the plant, due to regular wear and tear or otherwise, shall be made good before handing over of complete Ventilation system to customer.

11.2 **Instruments to be used for PG test shall be additionally supplied over and above the instruments shown in tender P&IDs.** PG test equipment being supplied, installed and commissioned for each unit, shall be retained by employer after completion of PG test.

12.0 EXCLUSIONS

Items of works listed below are excluded from scope of the Ventilation System supplier.

12.1 Construction of AWU/UAF room, foundations for Ventilation equipment's i.e. AWU, UAF, Pumps etc, roof/ wall openings for ducts, dampers/ louvres.

12.2 False ceiling, drop ceiling.

12.3 Slab cut out for running ducts, pipes, cables, grilles/dampers. Underground masonry trenches and masonry risers.

12.4 Various cable & pipe trenches, pipe pedestals, drains, sumps, insert plates for pedestals for pipe supports.

12.5 DCS Control panel for Operation and control of Ventilation System. However, all logic for implementation of control and monitoring from DCS shall be provided by successful bidder during detail engineering.

12.6 For Electrical scope, refer Electrical scope matrix sheet.

13.0 PAINTING / CORROSION PROTECTION REQUIREMENT

Refer customer specification, C-2A.

14.0 CONTROL PHILOSOPHY

Control of both Ventilation system shall be done from DCS based control panel located CCR area at 17.0M. Refer Customer Specification in Sub Section C2 A for details.

15.0 QUALITY ASSURANCE, QUALITY PLANS, INSPECTION & TESTING PROCEDURE:

As per the details given elsewhere in the specification.

16.0 SUB-VENDOR ITEMS

Sub-Vendor for Ventilation System is enclosed under Annexure-I, Sub- Section – E

17.0 DOCUMENTS TO BE SUBMITTED WITH THE BID

The documents to be submitted with the bid shall strictly as per list given under **SECTION-II**. Any documents other than those indicated in the list will not be reviewed and will not be considered as part of bid.

18.0 DRAWINGS/ DOCUMENTS REQUIRED DURING DETAIL ENGINEERING

List of drawings / documents along with submission schedule is attached in Annexure-V, Sub- Section –E.

SECTION: I

SUB-SECTION: C 2

CUSTOMER SPECIFICATIONS

SECTION: I

SUB-SECTION: C 2A

CUSTOMER SPECIFICATIONS
TECHNICAL REQUIREMENT

CHAPTER 25

AIR CONDITIONING AND VENTILATION SYSTEM

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CHAPTER – 25

AIR CONDITIONING AND VENTILATION SYSTEM

25.1 General

The air conditioning and ventilation system shall be provided so as to achieve inside design conditions for proper performance of equipment and personnel.

The extent of supply under this contract includes all items required to complete the intent of the contract notwithstanding the fact that such items may have been omitted from the specification or drawings.

The air conditioning and ventilation system shall also meet the requirements specified elsewhere in the specification.

25.2 Codes and Standards

The design, manufacture and performance of equipment shall comply with all currently applicable statues, regulations and safety codes in the locality where the equipments are to be installed. Nothing in this specification shall be considered to relieve the bidder of this responsibility.

Unless otherwise specified, equipment shall conform to the latest applicable Indian or IEC standard. Equipment complying with other authoritative standards such as British, USA, ASHRAE etc. will also be considered if it ensures performance equivalent or superior to Indian Standard.

25.3 Design Criteria for Air conditioning system

25.3.1 Design ambient conditions

Season	Dry Bulb Temp (Deg C)	Wet Bulb Temp (Deg C)
Summer	~~44~~ 47.8	~~26~~ 23.2
Monsoon	~~33~~ 40.6	~~27~~ 27.3
Winter	~~23~~ 29.4	~~8~~ 11.5

For other details of ambient conditions, refer published documents for meteorological data for Plant site. (Refer Volume II)

25.3.2 All equipments of air conditioning system shall be designed for continuous duty.

~~administrative building~~ etc, quantity of fresh air shall be minimum 1.5 air changes per hour.

25.3.5 Lighting load shall be minimum 2 Watts per Ft^2 or actual whichever is higher.

25.3.6 The occupancy for general area shall be minimum one person per 3 M^2 and for conference room the same shall be one per 1.5 M^2. In the control rooms, control equipment rooms etc, the occupancy may be one person per 20 M^2 (Minimum).

25.3.8 The supply & return air ducts shall be provided with automatic (motorised) fire dampers (of 90 minutes fire rating) at locations where ducts pass through walls & floors. Operation of these dampers shall be interlocked with the fire alarm system and shall also be possible to operate manually from the remote control panel. Required electrical contacts shall be provided in control panel of A/C plant for further wiring up to fire alarm panels.

25.3.9 Clarified water make up (if required) for complete air conditioning and ventilation system shall be provided by the bidder.

25.4 **Design Criteria for Ventilation system:**

25.4.1 The number of air changes per hour in evaporative/mechanically ventilated areas shall be as follows:

S. No.	Area	Air Changes
i.	Evaporative type ventilation system	8
ii.	General areas	20
iii.	Various pump houses: CW Pump House Filtered Water Fire Water Ash Water Ash Slurry Blower room (AHP) Gypsum building Lime preparation building Compressor building (SA/IA) DM Plant building	20
iv.	All Switch gear / MCC rooms and cable vaults.	30
v.	Battery and battery charger rooms and other hazardous areas where gaseous fumes are generated	30
vi.	Chlorination plant building	30

S. No.	Area	Air Changes
vii.	Chemical houses	30
viii.	DG set room	45

25.4.2 However in areas producing lot of heat, the temperature shall be the criteria, as follows:

- Inside temperature shall be minimum 3^0 C below the design ambient temperature during summer for evaporative cooled areas.
- Inside Temperature shall be maximum 3^0 C ~~below~~ Above the design ambient temperature during summer for mechanically ventilated areas.
- The criterion which gives higher number of air changes/higher quantity of air in either of the conditions as mentioned above shall be the basis for selecting the required air flow for that area.

25.4.3 All ventilation system shall operate on 100% fresh air. All mechanically ventilated areas shall be positively ventilated by means of supply air fans fitted with filters and/or gravity operated back draft dampers and exhaust fans. MCC/Switchgear rooms and cable gallery shall be provided with gravity operated back draft dampers in association with supply air fans in order to maintain positive pressure. Battery rooms & other fumes/ odour generating areas shall be negatively ventilated by means of exhaust air fans/ roof exhausters. Supply air fan catering for electrical areas (MCC & switchgear rooms) shall be provided with pre filters and fine filters and for other areas shall be provided with pre-filter only.

25.4.4 All the equipment of Ventilation system shall be designed for continuous duty.

25.4.5 The supply air ducts of evaporative type ventilation system shall be provided with automatic (motorised) fire dampers (of 90 minutes fire rating) entry in switchgear room, cable galleries etc. The operation of these automatic dampers shall be interlocked with the fire alarm system and shall also possible from the control panel remote manually.

25.4.6 Circulating water capacity for Air washer units shall be minimum 1 M^3/hr per 1000 M^3/hr of air flow. Velocity through piping shall be limited to 2 M/s and for gravity flow the same shall be limited to 1.5 M/s. Air distribution system shall be sized to have a constant frictional drop along its length and air velocity through ducts shall not exceed 12.5 M/s.

25.4.7 The air washer unit shall be designed for a maximum velocity of 2.7 M/s and at least 90% saturation efficiency.

25.4.8 For pumps, continuous motor rating (at 50^0 C ambient) shall be at least 10% above the maximum load demand of the pump in the entire operating range. For fans, compressors and blowers continuous motor rating (at 50^0 C ambient) shall be at least 10% above the maximum load demand at the design duty point.

25.4.9 Supply air fans, exhaust air fans & ventilation of each area shall be provided with local starter panels.

25.4.10 **REDUNDANCY OF EQUIPMENT**

- Air Washer Units and Unitary Air Filtration Systems shall be multiple units without any standby.
- Pumps for each Air Washer Unit shall be 2 x 100%
- Pumps for each Unitary air filtration system shall be 2 x 100%.
- Fans for each air washer unit shall be 2x50% capacity while for unitary air filtration unit shall be 1x100% capacity.
- Supply air fans/Exhaust air fans/roof exhausters shall be in multiplicity.

25.5.2 **Ventilation System**

25.5.2.1 The areas to be ventilated by Evaporative Cooling system are as follows:

a) All floors and area of turbine hall (TG building) other than the areas which are air conditioned.

b) Switchgear rooms and cable gallery areas of turbine building.

c) Any other evaporative area where equipment heat load is high and requires ventilation of evaporative cooling spaces.

25.5.2.2 The areas to be ventilated by unitary air filtration unit (UAF) are:

Non A/C areas of ESP building.

25.5.2.3 The areas to be ventilated by Mechanical ventilation process (using roof extractors/ supply air fans and/or exhaust fans) shall consist of but not limited to the following:

a) All the pump houses like fuel oil pressurizing pump house, CW pump house, ~~filtered water pump house, fire water pump house, Raw Water pump house, Fire Water Booster Pump house, ash water pump house, Ash disposal pump house, ash conveying blower room, lime preparation building, gypsum building etc.~~

b) Battery rooms, lube oil purification room, non A/C areas of SWAS room.

c) Switchgear Rooms/ MCC/ Battery rooms in various auxiliary buildings.

d) Air Compressor house.

~~e) Ash Blower room~~

~~f) Complete water treatment plant building facilities like PT, DM, Chlorination, CW treatment etc.~~

g) Air conditioning plant equipment areas.

h) A/C Plant room, MCC room, Battery room etc in service ~~& administration~~ building

i) Battery rooms of various remote I/O rooms.

j) Elevator machine rooms

~~k) Transfer towers/tunnels for CHP~~

~~l) Crusher House of coal and lime/Bunker Bay~~

m) All toilets & pantries (to be provided with propeller exhaust fan)

n) Non AC areas of service ~~& administrative~~ building.

o) Any other areas which are not covered either by air conditioning system or by evaporative cooling system.

25.6 System description Ventilation System

25.6.1 Evaporative Cooling System for Turbine Building

25.6.1.1 Each air washer unit (evaporative system) shall consist of the various sections such as Air Washer chamber/ casing, tank, distribution plates, set of metallic/ fabric filters at suction, suction louvers, bird screens, water headers, spray nozzle, piping, valves etc, drift eliminators, pumps fans, necessary controls & instrumentation and all other required accessories.

25.6.1.2 The air washer chamber casing shall be fabricated from 10 SWG black MS sheet with adequate stiffeners etc and various sections shall be bolted through gaskets to avoid leakage of water. The inside & outside of casing shall be protected by spray galvanization. The nuts and bolts used for joining the section shall be galvanized. The connection pieces shall have at least two (2) coats of rust inhibiting paints.

25.6.1.3 The air washer tank shall be fabricated from MS plate of minimum 6 mm thk and inside & outside surface of the tank shall be spray galvanized (minimum 60 microns DFT). Minimum depth of the tank shall be ~~600 mm~~ 800 mm. Tank construction shall be such that suction screen can be replaced while the unit is operating. Tank shall be provided with overflow, drain with valve, float valve make up connection with a gate valve backup, quick fill connection with globe valve etc. The overflow pipe shall be connected to drain pipe after isolating valve on drain pipe.

25.6.1.4 The distribution plate shall be fabricated out of 180 G galvanized steel sheet & galvanized steel angle supports with minimum 50% free area.

25.6.1.5 Air washer shall be two bank construction (one uni flow and other cross flow). All header and stand pipe shall be galvanized.

25.6.1.6 The spray nozzles shall be of brass or bronze with chrome plating and shall be self cleaning type. The nozzle shall be designed to produce fine atomised spray and shall be properly spaced to give a uniform coverage of the air washer section. The pressure drop through the nozzle should be in the range of 1.4 to 2.4 kg/cm^2.

25.6.1.7 The eliminator plates shall be of 24G thick GS sheets class 275 or from 100% virgin PVC of minimum finished thickness of 2 mm. The eliminator section made of GSS shall have minimum six bends. The PVC eliminators shall be UV stabilised using Titanium di-oxide and shall withstand the weathering test as per IS: 4892 for 500 hours. Type test report of compound testing carried out in any reputed laboratory shall be submitted for approval. All supports, tie rods and space bar shall be of either galvanized steel or PVC construction and shall be complete with suitable drip tray & drain pipe.

25.6.1.8 An airtight inspection door of 600 mm x 700 mm size and a water marine light be provided for each air washer tank.

25.6.1.9 Suitable number of brass screen shall be provided in the air washer tank to arrest the dirt entering the circulating water pump suction. Suitable GI grid shall be used inside the screen for reinforcement.

25.6.1.10 The specification for centrifugal fans shall generally be as indicated below. However the fan shall be of DIDW type for TG building and SISW for ESP building.

25.6.1.11 Saturation efficiency of air washers shall be minimum 90%.

25.6.2 **Unitary Air filtration**

25.6.2.1 Each unitary air filtration shall consist of casing, Tanks, Fans, distribution plates, moisture eliminator and water repellent type nylon filter with frame and support. Header and standpipe with support, spray and flooding type nozzle, Screen type, suction strainer, pumps, necessary controls & instrumentation and all other required accessories.

25.6.2.2 All equipments, components used in unitary air filtration system shall be in line with the specification requirements stipulated in air washer units above except the fans may be of SISW type.

25.6.2.3 Saturation Efficiency of unitary air filtration units shall be minimum ~~60%.~~ 70%

25.6.3 **Centrifugal Fan**

25.6.3.1 The casing shall be of welded construction fabricated with heavy guage galvanized sheet steel or MS sheet with spray galvanization (minimum 60 micron DFT). The minimum thickness of casing shall be 3mm. It shall be rigidly reinforced and supported by structural angles. The seams shall be permanently sealed air tight. Split casings shall be provided on larger sizes of fans. Casing drain with valves shall be provided wherever required.

25.6.3.2 The impeller shall have die formed backward curved blades tie welded to the rim and back plate to have a non overloading characteristic of the fan. Rim shall be spun to have a smooth contour. If required intermediate stiffening rings shall be provided. Shaft sleeves shall be furnished wherever required. The impeller, pulley and shaft sleeves shall be secured to the shaft sleeves shall be secured to the shaft by key and/ or nuts.

25.6.3.3 The bearing shall be self aligning, heavy duty ball, roller or sleeve bearing. They shall be easily accessible and lubricated properly from outside.

25.6.3.4 Inlet guard shall be spun to have a smooth contour. Inlet screen, if provided, shall be galvanized wire mesh of 25 mm square.

25.6.3.5 Base plate with necessary number of spring type vibration isolators or ribbed neoprene rubber pad or cushy foot mounting shall be provided. The vibration isolators should have minimum of 70% efficiency.

25.6.3.6 The first critical speed of the rotating assembly shall be at least 25% above the opening speed.

25.6.3.7 The fans shall be direct driven.

25.6.3.8 Transfer towers/tunnels of Coal handling plant shall mainly consists Supply air fans of DIDW type with pre and fine filters, Supply air ducting and grills, Exhaust air ducting and grills and Exhaust air fans of SISW type.

25.6.3.9 The ventilation system for the various areas shall be designed duly considering the factors such as temperature, relative humidity and maximum allowable concentration of gases present in the rooms, corresponding to international guidelines.

25.6.4 **Axial Fans**

25.6.4.1 These fans shall have fixed / variable pitch cast Aluminium blades of aerofoil design.

25.6.4.2 The fan casing shall be heavy gauge sheet steel construction.

25.6.4.3 Necessary rain protection cowl, inlet and outlet cones, bird protection screen, adjustable damper, vibration isolators, back draft dampers etc shall be provided.

25.6.4.4 The speed of the fan shall not exceed 960 rpm for fan with impeller diameter above 450 mm and 1400 rpm for fan with impeller diameter 450 mm or less. However for fans having static pressure of 30 MMWC or above the speed of the fan shall not exceed 1440 rpm for fan with impeller diameter of above 450 mm and 2800 rpm for fan with impeller diameter of 450 mm or less. The first critical speed of rotating assembly shall be at least 25% above the operating speed.

25.6.4.5 All other accessories like supporting structure etc as required shall be provided.

25.6.4.6 Fans of capacity 1000 cum/hr & lower shall be propeller exhaust type.

25.6.4.7 **All battery room & hazardous area shall be provided with fire proof supply/exhaust fans. These fans shall be epoxy painted.**

25.6.5 **Roof Ventilators**

25.6.5.1 The roof ventilators shall be "COWL" type.

25.6.5.2 Impeller shall be axial flow type, cast aluminium in one piece and dynamically balanced. Casing shall be heavy gauge sheet steel construction of 3 mm thick for impeller upto 750 mm diameter and 5 mm for fans with impeller of diameter 750 mm and above. In casing, access door with locking arrangement shall be provided.

25.6.5.3 The cowl shall be designed for weather protection of the fan also inside the roof on which the extractor is installed. Galvanized bird screen of 15 mm square be provided with the cowl. All accessories, steel supports as required will be provided.

25.6.5.4 The speed of the fan be limited as per limitation given above for axial fans.

25.6.5.5 All accessories rain protection exhaust hood, transformation piece, vibration isolators, steel support vibration isolators, bird screen, etc as required shall be provided.

25.6.5.6 The vibration level of fans shall be as per ISO: 14694.

25.6.6 **Specific Requirements**

i. The battery room shall be maintained at negative pressure to prevent leakage of fumes to outside from the battery rooms. The exhaust from the battery room shall be exhausted by means of duct with the outlet 1m above the roof level by means of tube axial fans. Also the ducting, grilles, fans, motors etc. provided for battery rooms to be painted with acid & fume resistant paint.

ii. In chlorination room, ducted exhausts shall be provided and exhaust air grilles will be located near the floor level. The fan, motors ducting and grilles shall be given acid and fume resistant paint.

v. For hazardous areas, fans with anti-spark characteristics to be provided.

vi. For elevator machine room, filtered air shall be supplied by supply air fan. Exhaust shall be through gravity dampers.

vii. Evaporative cooling ventilation fans shall be interlocked with fire protection system, to get the same tripped in the event of fire.

viii. Online non- chemical type scale preventer shall be used to avoid formation of scale in the Air washer /UAF water circuit to reduce the blockage in nozzles.

25.7 **Equipment Description**

25.7.9 **Centrifugal Pumps**

a)	Type	Horizontal Centrifugal, Axially split type casing pump
b)	Impeller	Closed type
c)	**Material of Construction**	
	i) Casing	2% Ni Cast Iron : IS:210 Gr. FG-260
	ii) Impeller	SS CF 8M
	iii) Wearing rings	Bronze
	iv) Shaft	SS 410
	v) Shaft sleeve	SS 316
	vi) Lantern ring	Brass / Bronze
	vii) Packing	Asbestos free
	viii) Base Plate	Carbon steel as per IS:2062
	ix) Speed	Maximum 1500 rpm

For other requirements of pumps refer Volume III, Chapter 34.

25.7.10 **Air Filters**

a) Pre Filter

1)	**Filter medium :**		
	i)	Washable non-woven synthetic fibre or high density Polyetylene (HDPE) media having 18G GSS/ 16G Al alloy frame. The filter media shall be supported with HDPE mesh on air inlet side & Aluminium expanded metal on exit side or GI wire mesh on both sides.
2)	**Type**		
		Flange/ Cassette	
3)	**Other requirements (as applicable) :**		
	a)	Suitable aluminium spacers be provided for uniform air flow;	
	b)	Casing shall be provided with neoprene sponge rubber sealing.	
	c)	Capable of being cleaned by water flushing.	
	d)	Density of filter medium shall increase in the direction of air flow in case of metallic filter.	
	e)	Filter media shall be fire retardant and resistant to moisture, fungi, bacteria & frost.	
4)	**Efficiency :**		
		Average arrestance of 65 - 80 % when tested in accordance with BS:6540/ASHRAE – 52 – 76/ EN-779.	
5)	Minimum thickness		50 mm
6)	Face Velocity		Not more than 2.5 m/sec.

7)	Pressure drop	Initial pressure drop - Not to exceed 5.0 mm WC at rated flow. Final pressure drop - Upto 7.5 mm WC.
8)	Location	
	a) Fabric type	1) At the suction of each AHUs
		2) At the suction of each Fresh air fan
		3) At suction of each supply air fan
		4) at suction of air washer & UAF (Water repellent nylon type)

b) **Fine Filters (Microvee type)**

1)	Type	Flange/ Cassette
2)	Construction	Washable non-woven synthetic fibre or high density Polyetylene (HDPE) media having 18G GSS/ 16G Al alloy frame. The filter media shall be supported with HDPE mesh on air inlet side & Aluminium expanded metal on exit side or GI wire mesh on both sides.
3)	Frame	Aluminium alloy of (minimum 16 gauge conforming to IS:737)
4)	Other requirements	a) A neoprene sponge rubber sealing shall be provided on either face of the filter frame. b) Capable of being cleaned by air or water flushing. c) Filter media shall be fire retardant and resistant to moisture, fungi, bacteria & frost.
5)	Efficiency	Average arrestance of > 90% when tested in accordance with BS:6540/ASHRAE–52-76/ EN-779.
6)	Minimum thickness	150 mm or 300 mm.
7)	Face Velocity	Not more than 1.2 m/sec for 150 mm and not more than 2.4 m/sec. for 300 mm.
8)	Pressure drop	Initial pressure drop - Not to exceed 10 mm WC at rated flow ; Final pressure drop-Up to 25 mm WC.
	Location	i) At the discharge of each individual AHU. ii) At the discharge of each Fresh air fan. iii) At the discharge of each supply air fan having static pressure of 30 mm WC or more.

25.7.12 Non- Chemical Type Scale Preventor

The unit shall be a non-chemical on-line type scale preventer not requiring any chemicals. Non-chemical water treatment system shall prevent the formation of hard scale in cooling circuits of air conditioning equipment. It shall work with a combination of Adsorption, and Turbulence. The inner core shall be able to convert the hardness salts into colloidal particles. The unit shall not require any electricity or any other source of energy. The unit shall not have any recurring, operating and maintenance cost. The size of the unit

shall be determined based on the water quality and water flow rate. The unit shall be installed in the condenser water circuit. The outer casing shall be of stainless steel. The method of checking the performance of system through computer simulation shall be provided.

25.7.13 **Low Pressure Air Distribution System**

I) Through Galvanized sheet steel fabricated rectangular ducting shall be provided for the low pressure air distribution system. The Galvanised sheets shall confirm to 275 GSM IS-277 or Aluminium alloy (grade 19000/ SIC or 3100/ NS 3 of IS 737).

The thickness of rectangular ducts shall be as follows:

	Larger dimensions of Duct, mm	Thickness of GI sheet (mm)	Thickness of Aluminium sheet (mm)
a.	Upto 750	0.63 (24 G)	0.8
b.	751 to 1500	0.80 (22 G)	1.00
c.	1501 to 2250	1.00 (20 G)	1.50
d.	2251 & above	1.25 (18 G)	1.80

The thickness of round ducts shall be as follows:

	Diameter of Round Duct, mm	Thickness of GI sheet (mm)	Thickness of Aluminium sheet (mm)
a.	150 to 500	0.63	0.8
b.	501 to 750	0.80	1.00
c.	751 to 1000	0.80	1.00
d.	1001 t0 1250	1.00	1.50
e.	1251 & above	1.25	1.80

25.7.13.1 **Duct Fabrication & Supports**

a. Duct fabrication shall be as per the latest relevant BIS/SMACNA standard.

b. Ducts for AC system may be site fabricated or factory fabricated and installed at site. However in case of partly used factory fabricated ducts, vendor shall take back the unused ducts.

c. The ducts routed inside the buildings with larger side greater than 2250 mm shall be supported by 16mm MS rods and 50x50x3 mm MS double Angles while those below 2250 mm shall be supported by 10mm MS Rods and40x40x3 MS angles. The duct supports shall be at a distance of not more than 2000 mm for A/C system. The MS rods for these ducts routed inside the building shall be hung from the existing floor beams/wall beams/roof beams/columns as provided by the owner with provision of necessary auxiliary or special steel members or by hooks or can be provided by contractor by dash fasteners fixed to the ceiling slab. No supports shall be taken from horizontal/vertical bracings of the structures. All items of duct support including MS rods, MS angles and double angles, auxiliary or special steel members, hooks, dash fasteners coach

screws and all other supporting material required shall be provided by the bidder.

d. Where the sheet metal duct connects to the intake or discharge of fan units, a flexible connection of fire retarding, at least 150 mm width shall be provided of closely woven, rubber impregnated double layer canvas or neoprene coated fibre glass.

e. All curves, bends, offsets and other transformations shall be made for an easy and noiseless flow of air. The throat of every branch duct shall be sized to have the same resistance in the main duct to which the branch duct is connected. All elbows shall have the throat radius of at least seventy five (75) percent of the duct width. In case the throat radius is smaller, suitable single thickness vanes of approved details shall be provided.

f. Wherever duct passes through wall, all the openings between masonry and duct work shall be neatly caulked or sealed to prevent movement of air from one space to the adjoining space. Where duct passes through the floor, at the lowest point in the elbow a drain trap of 100 mm width across the width of the duct and 50 mm deep shall be provided with suitable gauge valve.

g. Access doors shall be provided in the duct work or casing on the both sides of the equipment to be serviced. All access doors shall be of adequate size and shall be lined with substantial felt edging to prevent air leakage. Access doors shall be of built up construction, structurally strong and each shall have at least two hinges. Access doors shall have two rust proof window sash of approved type. All doors shall be set so as to flush with insulation or plaster finish on the duct.

h. Splitters and dampers shall be provided for equipment/area isolation and for proportional volume control of system. The same shall be minimum 16 gauge GS sheet of quadrant type with suitable locking device, mounted outside of duct in accessible position.

i. All the plenum chambers or connections to fans, dampers etc, shall be constructed in 18 gauge GSS, supported on 40x40x6 mm MS angle frames. All vertical angles shall be rivetted at approximately 125 mm centres to the casing. 'Pecora' or equivalent caulking compound shall be inserted between the base of angle and all masonary construction to which angles are fastened.

j. Wherever pipe hangers or rods pass through the ducts, light and stream lined casement around the same shall be provided to maintain smooth flow of air.

k. All air terminals shall be of mill finish extruded aluminium profile construction.

l. The proposed ducting scheme, duct sizes, location of supply air grilles etc shown on the enclosed drawings is tentative and subject to finalisation during detailed engineering by the contractor. The bidders shall furnish in their proposal quantities of ducting, duct insulation,

supply air grilles. However, these quantities may increase or decrease depending upon the final layout.

m. Each branch line shall have dampers to isolate the branch for maintenance purpose.

25.7.13.2 **Factory Fabricated Ducts**

a. All ducting shall be fabricated of LFQ (Lock forming quality) grade prime GI.

b. Unless otherwise specified here, the construction, erection, testing & performance of the ducting system shall conform to SMACNA – 1995 standards ("HVAC Duct Construction Standards – Metal and Flexible – second Edition – 1995" SMACNA)

c. All ductworks including straight sections, tapers, elbows, branches, show pieces, collars, terminal boxes and transformation pieces must be factory fabricated by utilizing the machines and processes as specified in SMACNA or by equivalent technology. In equivalent method, the fabrication shall be done by utilizing the following machines and process to provide the requisite quality of ducts and speed of supply :

i. Coil lines to ensure location of longitudinal seams at corners/ folded edges only to obtain the required duct rigidity and low leakage characteristics. No longitudinal seams permitted along any face side of the duct.
ii. All ducts, transformation pieces and fittings to be made on CNC profile cutters for required accuracy of dimensions, location and dimensions of notches at the folding lines.
iii. All edges to be machine treated using lock formers, flanges and roll bending for turning up edges.
iv. Sealant dispensing equipment should be used for applying built in sealant in Pittsburg lock where sealing of longitudinal joints are specified. Sealing of longitudinal joints are specified. Sealing of longitudinal joint is compulsory for ducts over 2" w.g static pressure.

d. All traverse connectors shall be 4-bolt slip on flange system with built in sealant, if any. To avoid any leakage additional sealant shall be used.

25.7.13.3 **Diffusers, Grills & Dampers**

Supply air diffusers/ grills with factory fitted volume control dampers to be provided for all air conditioned areas.

Return air diffusers of air conditioned areas shall be without volume control dampers.

The diffusers/ grills shall be extruded Aluminium of minimum 2mm thk with powder coating. The colour of powder coating shall be as per the interior decor.

Supply air grills shall be double deflection type and return air grills shall be single deflection type.

The nozzle type diffusers shall be fabricated from minimum 1.5 mm Aluminum sheet. The base shall be fixed type. The nozzle shall be of volute design with the spout diameter being half the base diameter and designed for low noise and long throw. The nozzle shall be able to rotate to any angle within the base. The whole assembly shall be powder coated as per interior decor.

All volume control (VC) dampers shall be operated by a key from the front of the grills/ diffusers and shall be of GI sheet.

The thickness of VC dampers shall be minimum 20 guage and thickness of louvers shall be minimum 22 gauge.

Suitable vanes shall be provided in the duct collar to have uniform and proper air distribution. Bank of baffles wherever required shall be provided.

Fire dampers shall be motor operated type and shall have fire rating of minimum 90 minutes.

All plenum chambers of connections to fans, dampers, etc shall be constructed in 18 gauge GS sheet and supported in MS angle frames.

All ducting surfaces coming in contact with corrosive fumes or gases shall be painted with three coats of epoxy paint over a coat of suitable primer.

25.7.14 **Thermal & Acoustic Insulation**

Application

a. All surfaces to be insulated both thermally and acoustically shall be thoroughly cleaned, dried and an adhesive be applied @ 1.5 kg/ sqm on the surface (CPRX compound of Shalimar Tar products or equivalent).

b. Insulation material (either expanded polyestrene foam or glass wool/ glass fibre or equivalent) shall be struck to the surface. All the joints shall be sealed with bitumen.

c. Insulation mass to be covered with 500 gauge polythene sheet with 50 mm overlaps and sealing all joints on hot side.

d. Insulation finish of types specified under shall be provided thereafter.

25.7.14.1 Type of Insulation & Finish

S. No.	Surfaces	Insulation Material	Insulation Form	Thick, (mm)	Finish, (mm)
1	Supply & Return air duct of AC system	Resin bonded glass wool or closed cell elastomeric (AI) Nitrile rubber	Roll/ Slab Sheet	50	F-3
				19	No separate finish required
10	Exposed air duct	Resin bonded glass wool	Roll	50	F-4

25.7.14.2 Specification for insulation shall be as follows:

Insulation Material	Code	Thermal Conductivity (w/m/Deg C)	Density, kg/ m^3
Resin bonded glass wool	IS:8183	0.049 at 50 Deg C	i) 24 (for thermal insulation) ii) 48 (for acoustic insulation)
Mineral wool pipe section Min Gr 2	IS 9842	0.043 at 50 Deg C	144

Insulation Material	Code	Thermal Conductivity (w/m/Deg C)	Density, kg/ m^3
Closed cell Elastomeric Nitrile rubber		0.036 at 20 Deg C	60-70

Note : Insulation for HVAC application shall be CFC/ HCFC free.

25.7.14.3 The specification for various finishes shall be as follows:

a) **Finish F-1**

Step – 1 Wrapping of Poly- Bonded Hessain (PBH- to act as vapour seal) on outer surface of insulation with 50 mm overlap stitching and sealing of overlap with synthetic adhesive like CPRX or equivalent compound.

Step – 2 The surface then shall be wrapped with 19 mm mesh 24 SWG GI wire netting, butting all the joints and laced down with 22 SWG lacing wire.

Step – 3 Sand cement (4:1) plaster shall be applied in two layers totalling to 12.5 mm thick. The second layer being brought to a smooth finish. A water proofing compound shall be added to cement before its application.

b) **Finish F-2**

Step – 1 Insulation shall be covered with 500 g polythene with 50 mm overlap and sealing of overlap with synthetic adhesive like CPRX or equivalent compound.

Step – 2 Same as Step-2 of Finish F-1 above.

Step – 3 Same as Step-3 of Finish F-1 above.

c) **Finish F-3**

Step – 1 Same as Step-1 of Finish F-2 above.

Step – 2 The polythene shall be covered with 30 gauge Aluminium sheet and locking of joints with self locking screws at a pitch of minimum 100 mm.

d) **Finish F-4**

Step – 1 Same as Step-1 of Finish F-1 above.

Step – 2 Same as Step-2 of Finish F-1 above.

Step – 3 Same as Step-3 of Finish F-1 above.

Step – 4 Application of 3 mm thk coat of water proofing compound "SHALIKOTE 30" or equivalent and wrapped with fibre glass RP tissue followed by final coat of 3 mm thk water proofing compound "SHALIKOTE 30" or equivalent over thr RP tissue.

Step – 5 After the above treatment, 22G Aluminium sheet cladding, properly stitched at all joints shall be provided over the external surface.

For all inspection covers and hatches on equipment, pump casing, valve bodies and flanges (100 mm & above), insulation shall be applied so as to facilitate removal without minimum damage to the insulation in 24 gauge GI box or 22 gauge Aluminium sheet metal boxes which are bolted together around the equipment. However continuity of the vapour seal between the static and removable portions of the insulation is maintained.

25.7.14.4 **ACOUSTIC INSULATION**

a) All ducts up to a distance of 5 m from AHU shall be acoustically lined from inside with 25 mm thk resin bonded glass wool of 48 kg/ cum density with 30 gauge perforated Aluminium sheet having 5 mm dia perforation at 8 to 10 mm centre to centre distance. Insulation shall be fixed on wooden frame of 600 x 600 mm dimension.
b) Fibre glass tissue sheet shall be applied over the outer surface of insulation before applying perforated Aluminium sheet. Application of acoustic insulation shall be in line with requirements specified above.

25.7.15 **Piping and Fittings**

Material of Construction for Piping & Fittings

a)	Piping for Chilled and Condenser water	Heavy grade-IS:1239 or Equivalent upto150 NB and IS:3589 or Equivalent for pipes beyond 200 lines NB with thickness as indicated
b)	Refrigerant piping	Seamless steel tubes conforming heavy grade IS:1239 or copper tubes as per IS:2501 (copper material as per IS:191 hard copper grade).
c)	Drain piping	Same as (a) above & galvanized as per IS:4736
d)	Fittings	1) The steel fittings shall conform to ASTM A234 Gr. WPB and dimensional standard to ANSI 16.9/ANSI B16.11 / equivalent for sizes 65 NB and above. 2) For sizes 50 NB and below, the material shall conform to ASTM A-105. 3) All steel flanges shall be of slip on type and shall conform to ANSI B 16.5 4) For pipe sizes above 350 NB, fabricated fittings from sheets of adequate thickness may be used. The bend radius in case of mitre bends shall be minimum 1.5 times the nominal pipe

		diameter and angle between two adjacent sections shall not be more than 22.5 deg and shall be as per BS:2633/BS:534. 5) Fittings, flanges and pipe joints of refrigerant piping shall conform to ANSI B31.5

25.7.16 **Valves**

i. Valves shall have full size port and Suitable for horizontal and as well as vertical installation.

ii. Valves for regulating duty shall be of Globe type suitable for controlling throughout its lift.

iii. Gate, Globe and stop Check valves shall have bonnet back seat to facilitate easy replacement of packing with the valves in service.

iv. All Safety / relief valves shall be so constructed that the failure of any part does not obstruct the free discharge.

v. Manual gear operator be provided for valves of size 200 NB and above.

vi. All valves with rising stem shall have position indicators.

vii. All valves shall be provided with locking arrangement.

viii. The refrigerant line valves shall have steel or brass body with TEFLON gland packing. The construction of disc shall be either globe or angle type. The valve seat shall have white metal lining or equivalent.

ix. The butterfly valves shall be designed as per AWWA C 504 and designed to fit between flanges. The butterfly valves shall be provided with flow control lever, black nitrile rubber integrally moulded seating, disc of aluminium bronze to BS 1400 Gr. AB2/AB1, shafts of stainless steel AISI 410. The butterfly valve shall be rated for 16 bar; body/disc tested at 24 bar and seat at 14 bar.

x. Balancing / Controller Valves:

The valves of sizes 32 mm to 65 mm dia shall be of gun metal / cast iron construction with screwed ends angular design digital hand wheel with locking facility. Whereas valves of sizes 75 mm and above shall be of cast iron construction with internal parts of SS 410 and EPDM / nitrile seat with flanged ends

25.7.17 **Instruments, Protective Devices and Interlock**

On-off thermostat with adjustable setting shall be provided with temperature control. Interlocks shall be provided such that compressor can start only after starting the air handling fan. Provision shall also be made to interlock the compressor with condenser water flow switch, chilled water flow switch / circulation pump. Safety devices such as high/low pressure cut out, hermetic motor winding thermostat etc. shall be provided. HP cutout shall be manual

reset type while LP cutout shall be auto reset type. The control system shall be PLC based with redundant processor, power supply and communication modules, with CRT operator interface and peripherals serial link shall be provided for transfer of important signals to the DCS in the central control room.

Strip heaters shall be provided with an adjustable thermostat to control the temperature and a safety thermostat and safety interlock shall be incorporated to cut-off the electrical supply to the heater whenever there is failure of airflow.

Fire dampers (solenoid operated) shall be installed at places where supply air duct crosses fire barrier wall, floor slab, return air space (near the wall separating AHU rooms / PAC rooms and A/C area). The fire damper shall be of the same fire resistance as the structure but in no case less than 120 minutes and should be energized to close and the air conditioning equipment shall be tripped off in the event of fire.

25.7.18 **Gravity Damper**

Gravity dampers (self acting dampers) are provided to ensure pressurization of electrical rooms, switch gears rooms, substations etc. Dampers shall be of gravity type designed such as not to allow infiltration of air from outside. The louvers of the dampers shall be freely mounted on Spindles to allow the damper to open freely with the pressure developed in the premises. The damper shall be provided with flange at the inlet, the pressure inside the premises shall be 1-2mm WC.

25.9 **Plant control for Evaporative cooling and Ventilation system**

a) General

i. Brief scheme of controlling the operation is described below. Detailed description of the control system for safe and efficient operation of the plant shall be elaborated, got approved from Owner. The descriptions in the sub-sections of the Control & Instrument sections shall also be referred to.

b) Air Washer Units (AWU) & Unitary Air Filtration Units (UAF)

i. Air washer units shall be started/ stopped by initiation from OWS provided in control room of air conditioning. Starting/ stopping of pumps shall be automatic upon such initiation.

ii. The operation of the pumps shall be interlocked with the low level of water in the sump. High level of the sump shall be annunciated. The standby pump shall be started automatically when the working pump is stopped/ tripped.

c) Miscellaneous control requirements

i. Separate emergency local stop push button shall be provided for each pump, fans etc. of Ventilation system.

ii. The status of each pump, fans, etc of ventilation system is available on OWS in control room locally.

iii. All the annunciations related to failure of equipments, tripping of equipments, source of failure / reason due to which the equipment is stopped / tripped, low & high limits of parameters such as level, temperature, pressure drop, pressure etc shall be provided for each pump, fan, AWU etc. in the control system.

iv. The fans (both supply and exhaust fans) associated with mechanical ventilation system shall be operated locally.

v. Fully wired, twenty percent (20%) spare annunciation windows shall be provided in all the panels.

S No	Description	Unit	Parameter		
			Main Control rooms	**ESP control rooms**	**Other areas**
1.12	**Ventilation System**		**Roof Extractors**	**Supply air fan**	**Exhaust fan**
a)	Type, Quantity, make & size				
b)	Location				
c)	Motor rating	kW			
2.0	**VENTILATION SYSTEM**				
2.1	Type of ventilation system as per spec provided	Yes/No			
2.2	Tunnel ventilation (VS-1/2)				
i)	Air changes per hour (guaranteed)				
ii)	Type & make of supply air fan				
iii)	Type & make of exhaust air fan				
iv)	Type of filter x its efficiency x standard				
v)	Material of construction of ducting x standard				
vi)	Material of construction of grills				
vii)	Air velocity units kept as per spec.	Yes/No			
2.3	Unitary type pressure ventilation in areas as per spec. provided	Yes/No			
2.4	Unitary type pressure				

S No	Description	Unit	Parameter		
			Main Control rooms	ESP control rooms	Other areas
	ventilation system:				
i)	Guaranteed number of air changes per hour				
ii)	Positive pressure (min.) maintained in the area (guaranteed)	Yes/No			
iii)	Type & make of fan				
iv)	Louvers/filter/ water spray system/ ducting/grills etc. as per spec. provided	Yes/No			
v)	Air velocity limits kept as per spec.	Yes/No			
2.5	Ventilation System: (Furnish Air changes considered per hour for the following areas):				
i)	Building (for DS system – chemical tank/ mixing/ metering pumps etc. for WT hopper complex)				
ii)	Battery Rooms				
iii)	Transfer Points				
iv)	Crusher house				
v)	Bunker floor area				
2.6	Ceiling fan with electronic regulators provided to suit in operator's cabin of SR-1/2				
2.7	Exhaust fan (propeller type or axial flow type) provided as per spec. in the specified areas	Yes/No			
2.8	Roof extractors provided as per spec. in the specified areas	Yes/No			

SECTION: I

SUB-SECTION: C 2B

CUSTOMER SPECIFICATIONS
PROJECT SPECIFIC GENERAL REQUIREMENTS

SECTION – VI

SPECIAL CONDITIONS OF CONTRACT (SCC)

1.0 TIME SCHEDULE OF THE PROJECT

Time is the essence of this contract. The date of Final Taking Over of the 1x800 MW Unit shall be 52 months from the date of Letter of Intent (LOI).

2.0 STATUTORY REQUIREMENTS

It shall be responsibility of the Contractor to obtain the necessary approvals of Inspection Authorities on behalf of the Owner, as may be required in respect of design calculations, manufacturing and erection procedure, testing etc as called for under the IBR, Indian Electricity Rules etc. All such documentation submitted to statutory authorities shall also be submitted to the Owner for his review. It shall also be the responsibility of the Contractor to furnish the requisite documentation as required by the Owner for getting the boiler registered under IBR, Electrical Installation sanctions etc.

2.1 Compliance with Laws and Directives

The Contractor shall in its performance of the contract and carrying out of the works ascertain and comply with all relevant Indian Laws and Directives.

The Contractor shall indemnify the Owner and their respective directors, officers, employees and agents against all governmental penalties and sanctions payable to a Competent Authority, together with any reasonable legal expenses incurred in connection therewith, to the extent arising out of any failure of the Contractor, any sub-Contractor or their respective agents or employees to comply in the performance of the works prior to "Final Taking-Over" and Completion of the Contract with any Indian law or Directive applicable to the construction, start-up and operational activities conducted at the site.

2.2 Divergences from Statutory Requirements

If the Contractor or the Owner finds any divergence between any Indian law or Directive and the technical specification, it shall immediately give to the other written notice specifying the divergence. The Contractor shall promptly upon becoming aware of the same, inform the Owner in writing of its proposed amendment for removing the divergence, and with the Owner's consent the Contractor shall entirely at its own cost and expense complete the works in accordance with the amendment.

2.3 Contractor to give notices and obtain approvals

a) The Contractor shall pay all fees for all clearances as per Annexure-G, GCC required to be given or paid to any Competent Authority in relation to the execution of the works.

b) Except in so far as the same are the responsibility of the Owner under this clause, the Contractor shall be responsible for obtaining any clearances, temporary way-leaves or other temporary rights of access, which may be required in connection with the execution of the works at his own cost. The Owner shall provide the Contractor with such assistance as the Contractor may reasonably request in connection with obtaining such clearances, temporary way-leaves and other temporary rights of way.

3.0 CODES AND STANDARDS

3.1 The plant equipment materials and works shall be completely designed, tested, supplied, erected, commissioned, etc. in all respects in accordance with the technical specification as per the acceptable codes & standards given below. The plant equipment shall be furnished as per the makes of Major Plant Equipment approved in the contract by the owner. Suppliers' equipment not identified in the contract or any change in the identified supplier shall be subject to Owner's approval.

3.2 The equipment, systems and works covered under this contract shall be carried out in accordance with the latest status, regulations and safety codes (as applicable to the locality where the equipment will be installed); as well as applicable portions of the current editions of the relevant codes and standards of professional bodies or with the standards and codes of the Government of India, and in accordance with the applicable portions of the following enactments, codes and standards in particular:

a) Indian Boiler Act and rules and regulations framed thereunder

b) Electricity Act 2003 and rules and regulations framed thereunder

c) Indian Factories Act and rules and regulations framed thereunder

d) Indian Explosives Act and rules and regulations framed thereunder

e) Indian Petroleum Act and rules and regulations framed thereunder

f) Bureau of Indian Standards (BIS)

g) British Standards Institution (BS)

h) National Electrical Code

i) Central and State Pollution Boards

j) Ministry of Environment and Forests

k) Indian Electricity Rules

l) Tariff Advisory Committee

m) American Society of Mechanical Engineers (ASME)

n) American Institute of Electrical Engineers (AIEE)

p) American Petroleum Institute (API)

q) American Society of Testing Materials (ASTM)

r) Hydraulic Institute of USA

s) National Electrical Manufacturers' Association (NEMA)

t) American Water Works Association (AWWA)

u) American Standards Association (ASA)

v) American Institute of Steel Construction (AISC)

w) National Board of Fire Under Writers

x) Insulated Power Cable Engineers Association (IPCEA)

y) Any other law or act are rule are standard applicable to the contract.

All works must be in accordance with the above mentioned codes or equivalent.

3.3 The design of steam generator shall meet or accede to all the requirements of latest editions of Indian Boiler Regulations (IBR). Any other standards acceptable to IBR can also be considered, provided the requirements of that standard are equivalent or more stringent that the IBR requirements. Wherever the specification stipulates requirements in addition to those specified in IBR, the same shall also be complied by the Contractor. In all above cases specific approval of concerned Chief Inspector of Boilers shall be obtained by the Contractor at its own cost/expenses before manufacture of the equipment.

In cases where IBR does not govern, other International Standards, established to be equivalent or superior to the Codes and Standards specified, are also acceptable. However, in the event of any conflict between the requirements of the equivalent codes and standards, any of the laws, rules, regulations and so forth specified herein and the requirements of the Indian Standards/Regulations, the latter or the more stringent requirements shall govern, unless specified otherwise. Owner's decision shall be final and binding in this regard.

3.4 All equipment, supplies, systems, works and service covered under this contract shall comply with the requirements of the various International and Indian acts, codes, standards, latest statutes, regulations and safety codes as applicable in the locality where the equipment/systems will be installed. Wherever any code, standard or regulation is specified, the latest edition thereof shall be applicable. Nothing contained in the bid documents shall be construed to relieve the Contractor from his obligation to comply with each and every statutory requirement according to the applicable laws. The Contractor shall fully acquaint himself with these requirements and shall ensure compliance with them.

3.5 The Contractor's scope of supply shall include items such as thermowells, control valves and other in-line devices for main steam, feed water system etc. falling under the purview of Indian Boiler Regulation (IBR) Act. It shall be the responsibility of the Contractor to obtain the necessary approval of the concerned Inspecting Authority/Chief Inspector of Boilers at its own cost/expenses for the design and design calculations, manufacturing and erection procedures as called for under the Indian Boiler Regulations Act for all items requiring such certification; as well as necessary approval of the concerned statutory authorities such as Chief Inspector of Explosives; and Environment Pollution Control Authorities etc within the quoted lump sum price indicated in his proposal.

4.0 INSPECTION PROCEDURE

Only after having obtained satisfactory results of internal inspection and ensuring that all reference documents such as purchase specifications, drawings, QAP's and Testing Procedure for the purpose of inspection are approved by the Owner, the Contractor shall call the Owner's representative for inspection in line with requirements of the bidding documents. At the time of inspection, the Contractor shall make all the above documents readily available at the sub-Contractor's works where the inspection is to be carried out by the Owner's authorized representative.

The Contractor shall submit a monthly inspection plan in line with QAP coordination procedure approved by the Owner.

4.1 INSPECTION, TESTING AND INSPECTION CERTIFICATES

4.2 The word 'Inspector' shall mean the Project In charge 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.

4.3 The Inspector shall have access at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection and if part of the works is being manufactured or assembled on other premises or works, the Contractor shall obtain permission to inspect for the Project In charge and for his duly authorized representative as if the works were manufactured or assembled on the Contractor's own premises or works.

4.4 The Contractor shall give the Owner fifteen (15) days written notice of any material being ready for testing. Such tests shall be to the Contractor's account except for the expenses of the Inspector. The Inspector, unless the witnessing of the tests is virtually waived and confirmed in writing, will attend such tests within fifteen (15) days of the date on which the equipment is noticed as being ready for test/inspection failing which the Contractor may proceed with test which shall be deemed to have been made in the Inspector's presence and he shall forthwith forward to the inspector duly certified copies of test reports.

The Owner’s engineering personnel will inspect the shop performance test of major equipment for which necessary facilities shall be provided by the Contractor.

4.5 The Project In charge shall within fifteen (15) days from the date of inspection as defined herein give notice in writing to the Contractor, or any objection to any drawings and all or any equipment and workmanship which are in his opinion are not in accordance with the contract. The Contractor shall give due consideration to such objections and shall either make modifications that may be necessary to meet the said objections or shall inform in writing to the Inspector giving reasons therein, that no modifications are necessary to comply with the contract.

4.6 When the factory tests have been completed at the Contractor's or sub-Contractor's works, the Project In charge shall issue a certificate to this effect fifteen (15) days after completion of tests. However, if the tests are not witnessed by the Inspector, the certificate shall be issued within fifteen (15) days of the receipt of the Contractor's test certificate by the Project In charge. Non-issue of such a certificate within the stipulated time shall not prevent the Contractor from proceeding with the works. The completion of these tests, or the issue of the certificates shall not bind the Owner to accept the equipment should it, on further tests after erection be found not to comply with the contract.

4.7 In all cases where the contract provides for tests whether at the premises or works of the Contractor or any sub-Contractor, the Contractor, except where otherwise specified shall provide free of charge such items as labour, material, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Inspector to carry out effectively such tests on the equipment in accordance with the contract and shall give facilities to the Inspector or to his authorized representative to accomplish testing.

4.7.1 The inspection by Owner and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed Quality Assurance Program forming a part of the contract.

4.8 To facilitate advance planning of inspection in addition to giving inspection notice, the Contractor shall furnish quarterly inspection program indicating schedule dates of inspection at "Customer Hold Point" and final inspection stage. Updated quarterly inspection plans shall be made for each three consecutive months and shall be furnished before beginning of each calendar month by the contractor.

4.9 All inspection, measuring and test equipment used by Contractor shall be calibrated periodically depending on its use and criticality of the test/measurement to be done. The Contractor shall maintain all the relevant records of periodic calibration and instrument identification, and shall produce the same for inspection by Owner. Wherever asked specifically, the Contractor shall re-calibrate the measuring/test equipments in the presence of Owner.

5.0 PRE-COMMISSIONING AND COMMISSIONING ACTIVITIES

5.1 As soon as the facilities or part thereof has been completed for operation and structurally and before start-up, each item of the equipment and systems forming part of facilities shall be thoroughly cleaned by the contractor and then it should be inspected jointly by the Owner and the Contractor for correctness of and completeness of Plant or part thereof and acceptability for initial pre-commissioning tests, commissioning and startup at site. The list of commissioning tests to be performed shall be as mutually agreed and included in the Contractor's quality assurance program as well as those indicated in the technical specifications.

5.2 The Contractor's pre-commissioning/commissioning/start-up engineers, specially identified as far as possible, shall be responsible for carrying out all the pre-commissioning tests at site. On completion of Inspection, checking and after the pre-commissioning tests are satisfactorily over, the commissioning of the complete facilities shall be commenced during which period the complete facilities, equipments shall be operated integral with sub-systems and supporting equipment as a complete plant.

5.3 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 (6) months prior to the respective implementation. The Owner will approve final verification of cleanliness.

5.4 The time consumed in the inspection and checking of the units shall be considered as a part of the erection and installation period. Contractor should not be given any time extension on this account.

5.5 The checkouts during the pre-commissioning period should be programmed to follow the construction completion schedule. Each equipment/system, as it is completed in construction, should be checked out and cleared by the contractor. The checking and inspection of individual systems should then follow a prescribed commissioning documentation such as Standard Check List/Testing Schedule/ Commissioning Schedule approved by the Owner.

5.6 The Contractor during initial operation and Trial Operation/ 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.

5.7 Contractor shall furnish the commissioning organization chart for review and acceptance of Owner. The chart should also contain:

i) Biodata including experience of the Commissioning Engineers.
ii) Role and responsibilities of the Commissioning Organization members.
iii) Expected duration of posting of the above Commissioning Engineers at site.

5.8 **Trial Operation**

A. Notice Of Readiness For The Trial Operation

After completion of pre-commissioning activities as detailed above, the contractor shall give 30 days advance notice in writing to the OWNER for the commencement of Trial Operation, after fulfillment of following contractual obligations:

(i) (a) Completion of pre-commissioning activities, outstanding works, etc.
(b) Submission of signed protocols in respect of completion of all the systems/sub-systems/equipments.
(ii) Submission of all operating and maintenance manuals, as-built drawings, final P&IDs, electrical one line drawings and control diagrams and other information as may be specified in the Technical Specification required by the OWNER for the safe and reliable operation of the plant.
(iii) Supply of all Commissioning spares, Mandatory Spares, Special tools & tackles.

The OWNER after satisfactorily fulfillment of above requirements shall give the consent to the Contractor for commencement of the Trial Operation.

B. Trial Operation Procedure

Trial Operation shall mean a period of 720 hours (30 days) continuous operation of Unit at various operating modes on firing with specified fuels. During this Trial Operation period, the unit shall be operated continuously for 720 hours (30 days) at loads as desired by the Owner. Out of this, 72 hours of continuous un-interrupted operation must be at full load.

If this 72 hours continuous un-interrupted full load operation is not achieved due to any reason, same shall have to be re-attempted and demonstrated. In case of any interruption upto 4 hours during 720 hours (30 days) operation, actual period of interruption must be added to 720 hours; however, if period of interruption / downtime is between 4 hours and 24 Hrs, then 24 hours will be added to 720 hours. In case the period of interruption / downtime of unit during Trial Operation is between 24 hours and 48 hours, then 48 hours will be added to 720 hours and if period of interruption/down time is more than 48 hours, then the Contractor would be under obligation to repeat the entire trial operation procedure as specified at clause 5.8, SCC, depending on the circumstances of down time, its point of occurrence during Trial Operation etc.

C. For Declaration Of Successful Trial Operation By The Owner

The Contractor shall submit to the Owner, a trial operation report comprising of observations and recordings of various parameters to be measured in respect of the above trial operation shall be prepared by the Contractor. This report with details of the various observations made during trial operation; details of interruptions occurred; adjustments

made; and any minor repairs done shall also include the dates of start and finish of the trial operation and shall be signed by the representatives of both the Contractor and the Owner. Based on the observations, necessary modifications/repairs to the unit/plant shall be carried out by the Contractor to the full satisfaction of the Owner to enable the latter to accord permission to carry out the Guarantee tests on the facilities.

The trial operation shall be considered successful, provided that each item/part of the unit/plant can operate continuously at the specified operating characteristics, for the period of Trial Operation with all operating parameters within the specified limits and at or near the predicted performance of the equipment/Plant.

5.9 **Revenue Earned till Final Taking Over**

Any output of electricity, ash, gypsum, etc generated during the period from pre-commissioning/commissioning till final taking over shall be the property of the Owner. The Owner shall be entitled to receive and retain for its own use all revenues generated for the same. This shall be irrespective of whether the Owner has assumed the occupancy or possession of the Unit or not. The operation of the Unit subsequent to Trial Operation shall not relieve the contractor of any of its contractual obligations under this contract.

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

Refer Chapter-8, Volume-II, General & Schedules

7.0 **LIQUIDATED DAMAGES FOR SHORTFALL ON EQUIPMENT PERFORMANCE**

If the guarantees specified at Chapter-8, Volume-II of Bidding documents are not achieved by the Contractor in the performance guarantee test or within 90 days or a reasonable period thereof allowed by the Owner after notification by the Owner, the Owner may at his discretion reject the equipment/system and recover the payment already made or accept the equipment/system only after levying liquidated damages against the Contractor and such amounts calculated at the rates specified in the Chapter-8, Volume-II for shortfall in performance shall be deducted from the contract price (provided the shortfall is less than or up to 20% of Contract Price) :

7.1 If the performance shortfall is such that the performance shortfall exceeds three (3) percent of the guaranteed value then the Owner will be entitled (at the Owner's sole discretion) to reject the works, terminate the Contract, and recover from the Contractor any loss the Owner has suffered up to the contract price. The Owner will give credit for any part of the works which he retains. In case, the plant is rejected by the Owner, the price recovery from the Contractor will be done up to the whole contract price.

7.2 Failure to prove the performance of the plant/equipment as per guaranteed figures, which will lead to rejection as per clause 7.0 above, shall be treated as non-performance of the contract and in addition to the liquidated damages (plus GST as and if applicable) leviable for shortfall in the performance, the Owner will be entitled to revoke/invoke the contract performance security and realize the proceeds from the Bank without any demur, protest and/or objection by the Contractor.

Wherever Liquidated Damages (LD) is recoverable as per the terms of the contract, the same shall be recovered from the contractor along with GST (as and if applicable).

8.0 LIQUIDATED DAMAGES FOR TIME DELAY

If the Contractor fails to successfully complete the Final Taking Over of the Unit by the Owner as specified in clause no 10.1 of Special conditions of Contract, the Contractor shall pay to the Owner Liquidated damages plus GST (as and if applicable) for the delayed period at the rate as indicated in the clause 20.0 of GCC.

The total amount of Liquidated Damages for Delay shall be subject to a maximum of 10% (Ten percent) of the contract price plus GST (if and as applicable).

Wherever Liquidated Damages (LD) is recoverable as per the terms of the contract. The same shall be recovered from the contractor along with GST (as and if applicable).

9.0 EXTENSION IN THE CONTRACTOR'S PERFORMANCE

9.1 Basis of Extension

The Contractor may claim an extension of time for completion of the works fixed by the contract and if he is or will be delayed in completing the works by any of the following causes:-

a) extra or additional work ordered in writing.

b) the Owner's instructions, other than by reason of the Contractor's default

c) the failure of the Owner to fulfill any of his obligations under the contract.

d) events or circumstances of Force Majeure, provided however that such events or circumstances shall continue for a period of seven (7) days or more in respect of anyone occurrence or shall continue for a cumulative period of twelve (12) days or more in respect of more than one occurrence. However, this provision shall not apply in relation to events or circumstances of Force Majeure which occur after the unit is fired.

The Contractor shall only be entitled to an extension of time if the Owner receives a request for the extension of time under the contract except in those circumstances where the Owner defaults under the contract, causes the contract to be delayed or request the Contractor to carry out additional work.

9.2 Requirements for Extension

An extension of time will only be granted following detailed submission by the Contractor to the Owner of the cause and extent of the delay, immediately upon such cause being known to the Contractor, including, but not limited to

i) The basis of the claim for said delays.

ii) Details of how the incident impacted upon the Contractor's program with evidence that "Final Taking Over" can no longer be achieved within the guaranteed completion dates.

iii) Detailed cost breakdowns and time taken in respect of all additional equipment and services provided by the Contractor on Owner instruction in writing.

9.3 **Grant of Extension**

As soon as reasonably practicable following the occurrence of any of the circumstances described above, the Owner shall grant the Contractor from time to time in writing either prospectively or retrospectively such extension to the relevant completion date as shall be fair and reasonable provided always that

i) the Contractor shall not be entitled to any extension of time in respect of any delay to the extent that such delay is attributable to any negligence, default or improper conduct by it or its sub-Contractors or its or their respective agents;

ii) the Owner shall be entitled to take into account the effects of any deletion from the work at any time before "Final Taking-Over" of the relevant section;

iii) the Owner shall be entitled to have regard, in determining what extension of time is fair and reasonable in any particular circumstances, to the extent of the Contractor's compliance with its obligations; and

iv) details of how the incident impacted upon the Contractor's program with evidence that "Final Taking-Over" dates can no longer be achieved.

9.4 **Mitigation of Consequences of Delay**

In all cases where such an event for delay has occurred, the Contractor shall advise the Owner of -

i) the extent of the actual and contemplated delay and its anticipated effect upon the date of "Final Taking-Over".

ii) the Contractor's plans to take steps to overcome or minimize the actual or anticipated delay and the increased costs, if any, associated therewith, and

iii) the Contractor's plans to adopt any methods suggested by the Owner to overcome or minimize the delay and the increased costs, if any, associated therewith, and shall use all reasonable endeavors to take such steps and/or adopt such methods.

9.5 **Punch List and Outstanding Work**

The Contractor shall, in conjunction with the Owner, prepare and update on a continuing basis during the period between mechanical completion of each section of the power plant and final completion, punch lists (based on the preliminary punch list of outstanding items requiring completion or rectification before each section of the power plant is finally complete.

The Contractor shall rectify or complete to the standards specified in the contract and in accordance with the schedule stated in the punch list any outstanding items of work or plant noted as requiring rectification or as incomplete. In the event that the Contractor fails to commence and/or diligently proceed with the execution of any such outstanding items of work in accordance with such schedule, the Owner may arrange for the outstanding work to be done and the

reasonable cost thereof shall be certified by the Owner and deducted from the contract price or paid by the Contractor to the Owner.

The parties may in any event agree that any outstanding items of work shall be carried out by the Owner or shall otherwise be deleted from the punch list referred to above, subject to the agreement of any appropriate sum to be paid or allowed by the Contractor to the Owner in respect of such outstanding item.

9.6 **Use of the Unit Prior to Owner's Acceptance**

Owner reserves the right to take possession of and use for any intended purpose, any portion or all of any handed over but as yet unaccepted Unit. The taking of possession at any time or use of any of such portion of Unit shall not be deemed to be an acknowledgement of Owner acceptance of Unit and shall not relieve Contractor from his obligations under the Contract in this respect, until Owner's acceptance of the Unit, has occurred on Final Taking Over. Owner shall provide Contractor with reasonable and timely access to complete its obligations hereunder. It is the expectation of the Parties that any such modifications or repairs will be accomplished by Contractor with minimal interference with operation of the Unit, and that reduction in and shutdowns of Unit operations will be required only when necessary. The Contractor shall, however, keep the EPC Package and Works duly insured as per clause 18.0 of GCC against various applicable risks until the Final Taking-Over.

10.0 **FINAL TAKING OVER OF THE UNIT/PLANT**

10.1 **Final Taking over**

When the contractor has in relation to the unit:

(a) Successfully completed the trial operation.
(b) Successfully completed the performance guarantee test of the plant and demonstrated that all the guaranteed performance parameters are within the acceptable limits.
(c) Completed all the outstanding works and punch points.
(d) Supplied all recommended spares if applicable
(e) Completely paid the Liquidated Damages (if applicable) as per provision in the Contract.
(f) Completion of all formalities/ obligations with Custom Authorities for all imports against the Project and submission of suitable confirmation from the Custom Authorities.

Then the Contractor shall notify the Owner in writing about the completion of the above requisites for the Final Taking Over of the Unit. If such notice was given properly in accordance with the requirements of the contract and not prematurely, the Owner shall thereupon issue to the Contractor a "Final Taking-Over Certificate for the Plant".

10.1.2 Deleted

10.1.3 **Effect of Final Taking-Over**

Upon "Final Taking-Over" in respect of unit/plant, risk of loss or damage to the section (other than any part thereof excluded by the terms of the "Final Taking-Over Certificate") shall pass to the Owner and it shall take over the care, custody and control thereof from the Contractor.

However till the Final Taking-Over occurs:-

i. the contractor continue to depute its operating Staff & Engineer for satisfactory operation of unit and shall be fully responsible for safety of all plant & equipment.

ii. Continue to extend full Insurance cover as provided in the contract. In case of failure of the contractor to provide any of the Insurance cover, the Owner shall arrange the same at contractor risk & cost and deduct the cost from the contractor along with overheads.

iii. Continue to provide all lubricants/ oil/ chemical for satisfactory & safe Operation of the Unit till Final Taking-Over.

10.2 **Demobilization**

Prior to "Final Taking-Over" of the plant, the Contractor shall remove [subject to the Contractor producing the necessary clearance from the relevant authorities (Customs, Excise etc.), if required by law] from the site the following on written approval of the Owner

a) **Surplus Materials and Equipment***:* Any surplus materials and equipment not required in connection with the performance of the Contractor's obligations after "Final Taking-Over" of the last section of the power plant, provided that before doing so it shall offer such materials and equipment (including rolling stock) for sale to the Owner at a price to be agreed.

The liability for the payment of the applicable taxes/duties, if any, on the surplus material so re-exported and/or disposed locally shall be that of the Contractor. The Contractor shall also indemnify to keep the Owner harmless from any act of omission or negligence on the part of the Contractor in following the statutory requirements with regard to removal/disposal of surplus material. The Indemnity Bond shall be furnished by contractor as per proforma annexed at Annexure- M(c) enclosed in GCC, Volume I. Further, in case the laws require the Owner to take prior permission of the relevant Authorities before handing over the surplus material to the Contractor, the same shall be obtained by the Contractor on behalf of the Owner."

b) **Disposal of Scrap**: "The Contractor shall with the agreement of the Owner promptly remove from the site any 'Scrap' generated during performance of any activities at site in pursuance of the Contract. The term 'Scrap' shall refer to scrap / waste / remnants arising out of the fabrication of structural steel work and piping work at the project site in the course of execution of the contract and shall also include any wastage of cables during the termination process while installing the cables. The ownership of such Scrap shall vest with the Contractor except in cases where the items have been issued by the Owner from its stores for their installation only without any adjustment to the Contract Price. The removal of scrap shall be subject to the Contractor producing the necessary clearance from the relevant authorities (Custom, Excise etc.), if required by the law, in respect of disposal of the scrap. The liability for the payment of the applicable taxes/duties shall be that of the Contractor. The Contractor shall also indemnify to keep the Owner harmless from any act of omission or negligence on the part of the Contractor in following the statutory requirements with regard to removal/disposal of scrap. The Indemnity Bond shall be furnished by Contractor as per proforma enclosed in GCC. Further,

in case the laws require the Owner to take prior permission of the relevant Authorities before handing over the scrap to the Contractor, the same shall be obtained by the Contractor on behalf of the Owner".

c) **Debris:** Rubbish, debris etc. so as to take all practical measures to prevent damage to the Site or any other property on or near the Site or Work Area. As soon as reasonably practicable, but in any event prior to Final Taking Over, the Contractor shall remove and dispose of in accordance with all Applicable Laws all such rubbish, debris, etc. and any and all Contractor's Equipment, supplies, materials and wastes brought or produced by the Contractor on the Site or the Work Area.

d) **Labour and hutments:** Labour and workmen engaged by the Contractor for the Works along with their hutments, sheds and dwellings. Notwithstanding the foregoing, the Contractor shall be responsible for the removal of all temporary structures built on the Site.

10.3 **Damages for Delay**

If, in relation to any section of the power plant, the criteria for "Final Taking-Over" specified in clause 10.1 have not been satisfactorily achieved on or before the Guaranteed Completion Date in relation thereto, the Owner shall be entitled to deduct from the contract price or, at the Owner's discretion, to require the Contractor to pay to the Owner liquidated damages plus GST (if and as applicable) for delay at the rate set out in the General Conditions of Contract Clause no 20.0 in respect of each day during the period between the Guaranteed Completion Date and the actual date upon which such criteria were satisfied.

Where the Owner elects the Contractor to pay liquidated damages for delay it may do so no more frequently than monthly and the Contractor shall pay such damages within ten days of receipt of the Owner request.

11.0 AGGREGATE LIABIITY FOR LIQUIDATED DAMAGES

Contractor's aggregate liability to pay liquidated damages for delay in completion of project and for shortfall in guaranteed performance parameters, cumulatively shall not exceed twenty five percent (25%) of the Contract Price, which is a genuine pre-estimate of damages and not by way of penalty.

SECTION – V

ERECTION CONDITIONS OF CONTRACT

1.0 GENERAL

1.1 The following provisions shall supplement the conditions already contained in the other parts of this specification and documents and shall govern that portion of the work of this contract which is to be performed at site. The erection requirements and procedures not specified in these documents shall be in accordance with the recommendations of the equipment manufacturer, or as mutually agreed to between the Owner and the Contractor prior to commencement of erection work.

1.2 The Contractor upon signing of the Contract shall, in addition to a Project Co-coordinator, nominate another responsible officer as his representative at Site suitably designated for the purpose of overall responsibility and co-ordination of the Works to be performed at Site. Such a person shall function from the Site office of the Contractor during the pendency of Contract.

2.0 REGULATION OF LOCAL AUTHORITIES AND STATUTES

2.1 In addition to the local laws and regulations, the Contractor shall also comply with the Minimum Wages Act and the Payment of Wages Act (both of the Government of India) and the rules made there under in respect of its labour and the labour of its sub-contractors currently employed on or connected with the contract. All labour welfare schemes & rules to be followed by Contractor. However, these are minimum & and should be limiting criteria.

2.2 All registration and statutory inspection fees, if any, in respect of his work pursuant to this Contract shall be to the account of the Contractor. However, any registration, statutory inspection fees law fully payable under the provisions of the Indian Boiler Regulations and any other statutory laws and its amendments from time to time during erection in respect of the plant equipment ultimately to be owned by the Owner, shall be to the account of the Owner. Should any such inspection or registration need to be re-arranged due to the fault of the Contractor or his Sub-Contractor, the additional fees for such inspection and/or registration shall be borne by the Contractor.

2.3 OWNER'S LIEN ON EQUIPMENT

The Owner shall have lien on all equipment including those of the Contractors' brought to the site for the purposes of erection, testing and commissioning of the plant. The Owner shall continue to hold lien on all such equipment till the final acceptance and Final Taking Over of the plant and equipment. No material brought to the site shall be removed from the site by the Contractor and/or his Sub-Contractors without the prior written approval of the Engineer.

3.0 WELDING OF PRESSURE PARTS AND HIGH PRESSURE PIPING

The welding of all pressure parts and high pressure piping shall be in accordance with the following requirements:

Welding Equipment for high pressure (Boiler, PCP):

For GTAW process: HF Welding machines shall be used.
For SMAW process: Inverter based welding machine shall be used.

Contractor shall ensure the availability of sufficient welding equipment during each phase of project construction so as not to impede the progress of the project.

3.1 **Qualification of Weld Procedures**

Only qualified welding procedures as per ASME Section IX shall be used by contractor at site. Procedure, qualification records along with WPS shall be submitted for review. Welding procedure shall indicate all essential and nonessential parameters as per ASME Section IX. Makes of welding consumables shall be subject to Owner's approval.

3.2 **Welder's Qualification**

3.2.1 Welders, who are qualified in accordance with the latest applicable requirements of the Indian Boiler Regulations, shall be permitted to perform any welding work on the pressure parts and its attachment welding. In addition to such statutory qualification requirements, the welders shall also undergo a satisfactory pre-production qualification test to be conducted by the Contractor at site as per ASME Section IX in presence of Owner/Engineer, prior to performing work under these specifications. The services of an independent testing laboratory shall be retained by the Contractor to perform welder qualification tests for welders.

3.2.2 All the welders carrying out welding at site shall carry an identification badge, which shall indicate the category and the grade of welding for which they have been tested and authorized to carry out welding. All such badges shall be countersigned by the Owner.

3.3 **Records**

Welders' performance shall be monitored regularly and record of their performance shall be maintained by contractor in a manner acceptable to the Owner. Contractor shall maintain such records including record of procedure qualification & welder qualification and hand-over to the Owner at the end of work.

3.4 **Marking**

On completion of each joint, the welder shall mark his regularly assigned identification mark near the joint. The welder' side notification numbers, inspection stamps or code symbol stamps and any other information shall not be directly stamped on any alloy steel piping. In alloy steel piping, all such information shall be stamped on separate marking plate which shall be tack welded on pipe near the weld.

4.0 **HEAT TREATMENT**

4.1 Pre-heating, post-heating and post-weld stress relief operations of all welds, shall be performed in accordance with the requirements of applicable code.

Local post weld stress relieving heat – treatments shall be adopted only in cases where it is normally impracticable to subject the entire assembly as such for stress relieving operations. Heating may be by means of electric induction coils or electric resistance coils. Oxy-acetylene flame heating or exothermic chemical heating methods will not be permitted. Complete recording of the temperatures throughout the stress relieving cycle of the material and the weld subjected to heat treatment shall be made by means of a potentiometric recorder. Recorders other than those of potentiometric type shall not be used for such temperature recording during stress relieving operations.

4.2 The contractor & Owner's representative, at start and at the end of HT Cycle shall sign the time and temperature charts for heat-treatment.

4.3 After setting up the weld joint for heat treatment operation, the Owner's signature shall be obtained on the strips chart of the recorder prior to starting of heat treatment cycle. The right hand corner of the strip chart at the starting point of the heat treatment cycle shall contain details like the weld number, material, diameter and thickness, method of heating adopted, prescribed ranges of heat treatment temperatures, date of heat treatment, reference to item number of the Field welding Schedule as specified below etc.

5.0 Weld Edge Preparation

Preparation at site of weld joint shall be in accordance with details acceptable to the Owner. Wherever possible, machining or automatic flame cutting shall be used for edge preparation. Hand flame cutting will be permitted only where edge preparation otherwise is impractical. All slag shall be removed from cuts and all the hand cuts shall be ground smooth to the satisfaction of the Owner. Flame cutting of alloy steel pipe shall be avoided. Wherever such cutting is done, a 200 mm length at the cut face shall be removed by machining. Pneumatic hand tools such as edge preparation, tube cutting machine can be used.

6.0 CLEANING AND SERVICING

6.1 The inside of all tubes, pipes, valves and fittings shall be free from dirt and loose scales before being erected. All the pipelines shall be thoroughly blown and/or flushed. Each steam and water tubes shall be blown with compressed air and shall be subjected to 'ball test' before erection to ensure that no obstructions exist. A system for recording of all such operations shall be developed and maintained in a manner to ensure that no obstructions are left inside the tubes and no tubes are left uncleaned and untested.

6.2 All valves and valve actuators, and dampers and damper actuators, if any, shall be thoroughly cleaned and serviced prior to pre-commissioning tests and/ or Initial Operations of the plant. A system for recording of such servicing operation shall be developed and maintained in a manner acceptable to the Owner and to ensure that no valves or dampers including their actuators are left un-serviced.

6.3 All interior surfaces of the turbine shall be thoroughly cleaned prior to boxing–up to remove all traces of oil preservations.

7.0 FIELD WELDING SCHEDULE

The Contractor shall submit to the Owner, a certified and complete field

welding schedule for all the field welding activities to be carried out in respect of the pressure parts involved in the equipment furnished and erected by him, at least 90 days prior to the scheduled start of erection work at site. Such schedule will be strictly followed by the Contractor during the process of erection. The above field-welding schedule to be issued by the Contractor shall contain the following:

(a) Drawing No.(s)
(b) Location of the weld
(c) Size of the weld(outside diameter and thickness)
(d) Type of joints
(e) Material specifications
(f) Size of fillet on backing ring ,when the type of joint is with backing ring
(g) Electrode/filler metal specifications
(h) Number of welds per unit
(i) Quantity of filler metal per weld
(j) Indication of required Non-destructive Examination(NDE)for each weld
(k) Pre-heat temperatures for welding
(l) Process of welding
(m) Post-welding heat treatment temperature ranges, duration, under as specified at Clause4.0 -"Heat Treatment".
(n) Qualification details of weld procedures to be adopted as specified under as specified at Clause3.1 –"Qualification of Weld Procedures".

8.0 SITE RUN MISCELLANEOUS PIPING

Sketches or diagrams of the proposed routings of all piping not already indicated and routed on the shop drawings which were reviewed by the Owner, shall be submitted to the Owner for review. Owner's acceptance of such site routings shall be obtained before the piping is erected. All these site run piping shall be installed in such a manner as to present an orderly and neat installation. They shall be located as to avoid obstruction of access and passages. Valves, instruments or any other special items shall be located convenient for operation by the operating personnel. Pipe runs shall be plumb or level except where pitch for drainage is required. Pipe runs that are not parallel to the building structure, walls or column rows shall be avoided so that deflection of pipes between hangers does not exceed 6 mm. No miscellaneous pipe shall be routed and installed above or adjacent to electrical equipment.

9.0 THERMAL EXPANSIONS

All piping installation shall be such that no excessive or destructive expansion forces exist either in the cold condition or under condition of maximum temperature. All bends, expansion joints and any other special fittings, necessary to provide proper expansion, shall be incorporated. During installation of expansion joints and anchors, care must be taken to make sure that full design movement is available at all times for maximum to minimum temperature and vice-versa.

10.0 PIPING SUPPORTS

10.1 Hangers, supports and anchors shall be installed as required to obtain a safe, reliable and complete pipe installation. All supports shall be properly leveled and anchored when installed. The anchors shall be so placed that thermal expansion will be absorbed by bends without subjecting the valves or equipment to excessive strains.

10.2 The hanger assemblies shall not be used for the attachment of rigging to hoist the pipe into place. Other means shall be used to securely hold the pipe in place till the pipe support is completely assembled and attached to the pipe and building structures and spring support is set to accommodate the pipe way. All temporary rigging shall be removed in such a way that the pipe support is not subjected to any sudden load. All piping, having variable spring type supports, shall be held securely in place by temporary means during the hydraulic test of pipe system. Constant support type spring hangers used during hydraulic test shall be pinned or blocked solid during the test. After complete installation and insulation of the piping and filling of the piping with its normal operating medium, the pipe support springs shall be adjusted to the cold positions. If necessary, the spring support shall be re-adjusted to the hot positions after the line has been placed for service at its normal maximum operating temperature conditions. Electric arc welding only shall be used to weld all pipe supports to structural steel members that form part of the building supporting structure. The structural beams shall not be heated more than necessary during welding of supports and such welds shall run parallel to the axis of the span. All lugs or any other attachments welded to the piping shall be of the same material as the pipe.

11.0 PRESSURE TESTING

11.1 On completion of erection of pressure parts, a hydraulic test in accordance with the requirements of the Indian Boiler Regulations shall be performed by the Contractor.

11.2 All the valves, high pressure pipes and inter-connected pipes connecting the pressure parts shall be tested along with pressure parts. All blank flanges or any removable plugs required for openings not closed by the vales, and piping provided, shall be furnished by the Contractor. The pressurization equipment including water piping from the supply, needed for the above test shall also be furnished by the Contractor. Any defects noticed during the testing are to be rectified and the unit re-tested. If any welding is done on the pressure parts after the Hydraulic test, the Hydraulic test for that portion of pressure parts shall be repeated.

11.3 The hydraulic test shall be considered successful only on certification to that effect by the concerned inspecting Authority as per the provisions of the Indian Boiler Regulations and the Owner.

12.0 THERMOWELLS AND FLOW NOZZLES

12.1 All the thermowells and flow nozzles in the equipment furnished under the technical specifications shall be installed as a part of this work.

12.2 All thermowell connections incorporated in the steam service shall be plugged during the pressure testing and the blow out of steam piping systems. Upon completion of the blow out operation, all thermowells shall be installed and seam welded. Similarly, all flow nozzles in the steam lines shall also be installed only on completion of steam blowing operations unless otherwise agreed to by the Owner, depending upon the sequence of cleaning and purging operations to be adopted by the Contractor at the field.

13.0 INSULATION, LAGGING AND CLADDING

The provision of insulation, lagging and cladding of the various equipment and portion of the equipment covered under the Contract, shall be furnished by the Contractor as specified elsewhere or agree to separately in writing. Welds required for holding insulation on pressure parts shall be carried out by IBR qualified welder.

13.1 In case of equipment other than steam turbine, Lugs made out of MS rods of 5mm dia. conforming to IS-280 or equivalent shall be welded on the surface at intervals of 250mm pitch zigzag to support insulation. Mineral wool mats with wire netting on both sides shall be applied against the surface with lugs piercing through. The edges of mattress shall be laced together with galvanized MS0.71mm dia. (22 SWG) IS-280 or equivalent (soft) lacing wire.

Galvanized binding wire of 1.63 mm dia. (16 SWG) IS 280 or equivalent (soft) will be used crisscross between lugs to hold it. The lugs will then be bent over the netting.

13.2 Unless otherwise specified, all equipment insulation shall be covered with aluminum cladding / jacketing. The thickness of aluminum sheet shall not be less than 0.63mm. Galvanic corrosion shall be prevented by carefully avoiding permanent contact of aluminum cladding with copper, copper alloys, tin, lead nickel or nickel alloys including monel metal. Where cladding is attached to carbon steel or low alloy steels, the steel shall first be prime painted with zinc chromate and then painted with aluminum paint. The use of lead base paints for this purpose shall be avoided.

13.3 Prior to application of cladding, all surface imperfections such as ducts, cracks and voids shall be filled with insulation cement so as to form a smooth base for the final shall be machine rolled and formed. All over laps at longitudinal joints shall face downwards. The fixing of cladding shall be by means of screws and they shall be adequate in number and be so place is such location as to produce tight joints eliminating 'bellying'. The screws, as far as possible, shall be uniformly placed and on centers not exceeding 150mm except where insulated outside diameters are smaller than 230mm in which case spacing shall be on centers not exceeding 100mm. Self tapping type screws, of 12mm size of stainless steel / aluminum alloy as per the requirements shall be used. All joints wherever possible shall be lapped a minimum of 50mm. The overlaps of longitudinal joints shall be a 10mm turn back edge. Butt joints such as those at piping tees, shall be made using a rolled seam. Suitable provisions for expansion movement shall be provided in joints. Hinge doors sliding doors for convenience shall be provided in the cladding at all access openings, non-projecting connections, important codes stampings etc.

13.4 Piping, Pipe Fittings & Valves

All piping insulation and metal cladding furnished with the equipment to be erected shall be applied as specified herein.

13.4.1 Piping

The insulation on piping shall be applied using wire loops on 150mm centers. These wire loops shall be thoroughly embedded into the outer insulation surface and all cracks, voids and depressions shall be filled with insulating cement suitable for the piping temperature so as to form a smooth base for

application of cladding. The wires used for piping insulation shall be of 20SWG. The surface shall be smooth and uniform before applying the outer covering. All piping insulation ends shall be terminated at a sufficient distance from flanges to facilitate removal of bolts.

13.4.2 **Flanges**

Insulation on flanges shall be by means of blocks of insulating material securely bound to the flange by wire loops. Such blocks of insulation shall be long enough to overlap the adjacent pipe insulation by an amount equal to the thickness of adjacent pipe insulation. Smooth finish shall be obtained by the application of insulating cement. Alternatively, sectional pipe insulation of proper diameter may be used. Insulation on flanges shall not be done until the pipe and equipment have been in service during the initial operation and till all the flange bolts have been re-tightened.

13.4.3 **Bends and Elbows**

Insulation on bends and elbows shall be cut into sections sufficiently short to form a reasonable smooth external surface. After the application of insulation material in place, it shall be smoothly coated with insulating cement. Elbows may be insulated as above or alternatively by means of specially moulded insulation enclosures.

13.4.4 **Cladding**

Cladding shall be of aluminum sheet of thickness as per details given in detail Technical Specification shall be machine rolled and formed to accurately fit insulation curvatures. Cladding shall be secured using self-tapping screws. Screws shall be adequate number and so located as to produce tight joints. The spacing of screws shall be as far as possible uniform and on centers not exceeding 150 mm. For outside diameters less than 230mm, spacing of screws shall be on centers not exceeding 100mm adequate number of screws shall be provided for fixing the cladding and be so placed in such locations, as to produce a smooth cladding finish without bellying'. Insulated elbows having insulated diameters less than 330mm shall be provided with preformed smooth aluminum elbow jackets. Wherever possible, all joints should be lapped a minimum of 50mm with joints facing downwards and so placed that they are obscured from normal points of vision. All the joints in the cladding shall be made with suitable provisions for expansions. All butt joints such as those at piping tees shall be made using rolled seams. In addition, to prevent galvanic corrosion, suitable action, as stipulated as specified at Clause 13.5 below shall be taken.

13.4.5 **Valves and Fittings**

All valves and fittings installed in the pipelines shall also be applied with insulation and furnished with suitably shaped boxes so as to facilitate easy dismantling of the fittings. The insulation thickness for valves, valve fittings etc. shall be same as that used on the line on which they are installed. All voids shall be properly filled up with insulating material and as per the directions of the Owner.

13.5 **Protection of Equipment during Insulation Applications**

All equipment and structures shall be suitably protected from damage while applying insulating after completion of insulation. All equipment and structures shall be thoroughly cleaned and remove insulating materials which might have fallen on them.

14.0 **CODE REQUIREMENTS**

The erection requirements and procedures to be followed during the installation of the equipment shall be in accordance with the relevant Indian Electricity Rules & Codes, Indian Boiler Regulations, CEA Guidelines, ASME codes and accepted good practices, the Owner's Drawings and other applicable Indian recognized codes and laws and regulations of the Government of India.

15.0 **ELECTRICAL SAFETY REGULATIONS**

15.1 In no circumstances will the Contractor interfere with fuses and electrical equipment belonging to the other Contractor or Owner.

15.2 Before the Contractor connects any electrical appliances to any plug or socket belonging to the other Contractor or Owner, he shall:

(a) Satisfy the Owner that the appliance is in good working condition;

(b) Inform the Owner of the maximum current rating, voltage and phases of the appliances;

(c) Obtain permission of the Owner detailing the socket to which the appliances may be connected.

The Owner will not grant permission to connect until he is satisfied that

(a) The appliance is in good condition and is fitted with a suitable plug.

(b) The appliance is fitted with a suitable cable having two earth conductors, one of which shall be an earthed metal sheath surrounding the cores.

15.3 No electric cable in use by the other Contractor / Owner will be disturbed without permission. No weight of any description will be imposed on any such cable and ladder or similar equipment will rest against or be attached to it.

15.4 No repair work shall be carried out on any live equipment. The equipment must be declared safe by the Owner and a permit to work issued before any work is carried out.

15.5 The Contractor shall employ the necessary number of qualified, full time electricians to maintain his temporary electrical installation.

16.0 **REMOVAL OF MATERIAL**

No material bought to the site shall be removed from the site by the contractor and/or his sub-contractors without the prior written approval of the OWNER.

17.0 **INSPECTION, TESTING AND INSPECTION CERTIFICATES**

The provisions of the clause entitled Inspection, Testing and Inspection Certificates given in Volume II, Chapter 05: GTR shall also be applicable to the erection portion of the Works. The Owner shall have the right to re-inspect any equipment through previously inspected and approved by him at the Contractor's works, before and after the same are erected at Site. If by the above inspection, the Owner rejects any equipment, the Contractor shall make good for such rejections either by replacement or modification / repairs as may be necessary to the satisfaction of the Owner. Such replacements will also include the replacements or re-execution of such of those works of other Contractors and/or agencies, which might have got damaged or affected by the replacements or re-work done to the Contractor's work.

18.0 **ACCESS TO SITE AND WORKS ON SITE**

18.1 Suitable access to site and permission to work at the Site shall be accorded to the Contractor by the OWNER in reasonable time.

18.2 In the execution of the Works, no person other than the Contractor or his duly appointed representative, Sub-Contractor and workmen, shall be allowed to do work on the Site, except by the special permission, in writing by the OWNER or his representative. **Contractor shall ensure that permission for authorized persons shall only be requested from the Owner for the facilities/areas which are common to existing infrastructure of Units # 1 & 2.**

18.3 **CONTRACTOR'S FIELD PERSONNEL**

Subject to the prior approval of the Owner, the Contractor shall deploy only competent and experienced personnel in each field of Work. In order to seek such approval of the Owner the Contractor shall furnish to the Owner the resume and other necessary details of such personnel to be deployed by the Contractor for the Works. The Contractor shall forthwith upon the date of issue of the Letter of Award appoint suitably qualified and experienced persons acceptable to the Owner to fill the posts needed for the works. The Contractor shall keep the key personnel employed in connection with the Works as long as reasonably necessary to fulfill the Contractor's obligations under this Contract and such personnel shall, for so long as they may be engaged in connection with the Works, give substantially the whole of their time to the superintendence of the Works and shall not be removed from their posts or replaced without the prior written approval of the Owner, which approval shall not be unreasonably withheld or delayed. The person appointed as the Project Manager for the Works shall have full authority to act on behalf of the Contractor for all purposes in connection with the Contract. The Project Manager shall not be engaged in any project other than the Works and shall not be replaced or removed without the prior consent of the Owner, which consent shall not be unreasonably withheld or delayed. The Contractor shall notify the Owner of the Project Manager's normal place or places of work.

19.0 **CONTRACTOR'S SITE OFFICE ESTABLISHMENT**

The Contractor shall establish an Office at the Site and keep posted an authorized representative for the purpose of the Contract. Any written order or instruction of the Owner or his duly authorized representative shall be communicated to the said authorized resident representative of the Contractor and the same shall be deemed to have been communicated to the Contractor a this legal address.

20.0 **CO-OPERATION WITH OTHER CONTRACTORS**

20.1 The Contractor shall co-operate with all other Contractors or Workmen of the Owner, who may be performing other works on behalf of the Owner and the workmen who may be employed by the Owner and doing work in the vicinity of the works under the Contract. The Contractor shall also arrange to perform his work as to minimize to the maximum extent possible, interference with the work of other Contracts and their workmen. Any injury or damage that may be sustained by the employees of the other Contractors and the OWNER, due to the Contractor's work shall promptly be made good at his own expense. The OWNER shall determine the resolution of any difference or conflict that may arise between the Contractor and other Contractors or between the Contractor and the workmen of the OWNER in regard to their work. If the work of the Contractor is delayed because of any acts of omission of another Contractor, the Contractor shall have no claim against the OWNER on that account other than an extension of time for completing his works. OWNER shall have full access to visit the contractor's site at any time for inspection and surveillance checks.

20.2 The OWNER shall be notified promptly by the Contractor of any defects in the other Contractor's works that could affect the Contractor's Works. The OWNER shall determine the corrective measures if any, to rectify this situation after inspection of the works and such decisions by the OWNER shall be binding on the Contractor.

21.0 **DISCIPLINE OF WORKMEN**

The Contractor shall adhere to the disciplinary procedure set by the OWNER in respect of his employees and workmen at Site. The OWNER shall be at liberty to object to the presence of any representative or employee of the Contractor at the Site, if in the opinion of the OWNER such employee has misconducted himself or is incompetent, negligent or otherwise undesirable then the Contractor shall remove such a person objected to and provide in his place a competent replacement.

22.0 **CONTRACTOR'S FIELD OPERATION**

22.1 The Contractor shall keep the OWNER informed in advance regarding his field activity plans and schedules for carrying out each part of the works. Any review of such plan or schedule or method of work by the OWNER shall not relieve the Contractor of any of his responsibilities towards the field activities. Such reviews shall also not be considered as an assumption of any risk or liability by the OWNER or any of his representatives and no claim of the Contractor will be entertained because of the failure or inefficiency of any such plan or schedule or method of work reviewed. The Contractor shall be solely responsible for the safety, adequacy and efficiency of plant and equipment and his erection methods.

22.2 The Contractor shall have the complete responsibility for the conditions of the Work-Site including the safety of all persons employed by him or his Sub-Contractor and all the properties under his custody during the performance of the work. This requirement shall apply continuously till the completion of the Contract and shall not be limited to normal working hours. The construction review by the OWNER is not intended to include review of Contractor's safety measures in, on or near the Work-Site, and their adequacy or otherwise.

23.0 **PHOTOGRAPHS AND PROGRESS REPORT**

23.1 The Contractor shall furnish three (3) prints each to the OWNER of progress photographs of the work done at Site. Photographs shall be taken as and when indicated by the OWNER or his representative. Photographs shall be adequate in size and number to indicate various stages of erection. Each photograph shall contain the date, the name of the Contractor and the title of the photograph.

23.2 The above photographs shall accompany the monthly progress report detailing out the progress achieved on all erection activities as compared to the schedules. The report shall also indicate the reasons for the variance between the scheduled and actual progress and the action proposed for corrective measures, wherever necessary.

23.3 The Contractor shall submit the progress of work in Pen Drives/Hard-disk drives quarterly highlighting the progress and constraints at site.

23.4 No later than (10 days) after the end of each month, the Contractor shall submit to the Owner a Progress Report in respect of the period up to the end of such month. The Contractor shall in each such report supply information including: (i) identification and evaluation of all material problems and deficiencies in the Works or the supplies and full details of remedial actions planned with respect thereto and of any remedial action to be or being implemented; (ii) the extent of the Works performed and remaining to be performed, the status of construction activities as against the Time Schedule; (iii) details and explanations of any delay in meeting the Time Schedule along with remedial action planned with respect thereto and the extent to which payments have been received and remain outstanding; (iv) a record of meetings and material communications for the month; (v) specific progress in relation to start-up and any testing; (vi) schedule of key activities for the following three months; (vii) schedule of meetings for the following three months; (viii) details of any health and safety issues; (ix) schedule of outstanding correspondence and an action list there for; (x) description of status of documents submitted for approval; (xi) schedule of proposed changes and Change Orders and their status; and (xii) photographs taken that month of the Unit and the Site, showing progress made.

24.0 **MAN-POWER REPORT**

24.1 The Contractor shall submit to the OWNER, on the first day of every month, a man hour schedule for the month, detailing the man hours scheduled for the month, skill- wise and area-wise.

24.2 The Contractor shall also submit to the OWNER on the first day of every month, a man power report of the previous month detailing the number of persons scheduled to have been employed and actually employed, skill- wise and the areas of employment of such labour.

25.0 **PROTECTION OF WORK**

The Contractor shall have total responsibility for protecting his works till it is finally taken over by the OWNER. No claim will be entertained by the OWNER or the representative of the OWNER for any damage or loss to the Contractor's

works and the Contractor shall be responsible for complete restoration of the damaged works to original conditions to comply with the specification and drawings. Should any such damage to the Contractor's Works occur because of other party not being under his supervision or control, the Contractor shall make his claim directly with the party concerned. If disagreement or conflict or dispute develops between the Contractor and the other party or parties concerned regarding the responsibility for damage to the Contractor's Works the same shall be resolved as per the provisions of the as specified above. The Contractor shall not cause any delay in the repair of such damaged Works because of any delay in there solution of such disputes. The Contractor shall proceed to repair the Work immediately and no cause thereof will be assigned pending resolution of such disputes.

25.1 The Contractor shall include and provide for securely protecting and packing the equipment so as to avoid damage in transit and the Contractor shall be responsible for all losses or damages caused or occasioned by any defect in packing. All equipment shall be packaged in accordance with packing specifications as approved by the Owner.

All equipment and parts shall be appropriately protected against damage arising from exposure to moisture, heat, light or vibration during transit and storage as dictated by the nature of the equipment, the journey to site and the storage available at site. The Owner will take no responsibility for any damage done to the equipment enroute to the 'site of work' or 'place of delivery' whichever may occur due to the packing being faulty. Special packing with identification marks on packages should be provided for fragile materials. The identification marking indicating the name and address of the consignee shall be clearly marked by indelible ink on two opposite sides and on top of each of the packages. In addition, the Contractor shall include in the marking, gross and net weights, outer dimensions and cubic measurements.

Each bale or package shall be accompanied by a packing note quoting specifically the name of the Contractor, the number and date of the contract, the name of the office placing the contract, nomenclature of contents and any other information reasonably required by the Contractor to effectively handle each bale or package i.e. Reference Nos.

Dimensions of each package shall not exceed the maximum dimensions of packages that can be accepted for transport over the 'broad gauge system' of the railways concerned.

Notification of delivery or dispatch after obtaining Owner's approval to this effect in regard to each and every consignment shall be made to the Owner immediately after dispatch or delivery. The Contractor shall further supply to the consignee a priced invoice and packing account of all stores, containers, bundles and loose materials forming part of each and every consignment which shall be described fully in the packing account, and full details of the contents of packages and quantity of materials shall be given to enable the consignee to check the stores on arrival at destination.

26.0 **EMPLOYMENT OF LABOUR**

26.1 In addition to all local laws and regulations pertaining to the employment of labour to be complied with by the Contractor pursuant to GCC, the Contractor will be expected to employ on the work only his regular skilled employees with experience of the particular work. No female labour shall be employed after darkness. No person below the age of eighteen years shall be employed.

26.2 All travelling expenses including provisions of all necessary transport to and from Site ,lodging allowances and other payments to the Contractor's employees shall be the sole responsibility of the Contractor.

26.3 The hours of work on the Site shall be decided by the OWNER and the Contractor shall adhere to it. Working hours will normally be eight (8) hours per day – Monday through Saturday.

26.4 Contractor's employees shall wear identification badges while on work at Site.

26.5 In case the OWNER becomes liable to pay any wages or dues to the labour or any Government agency under any of the provisions of the Minimum Wages Act, Workmen Compensation Act, Contact Labour Regulation Abolition Act or any other law due to act of omission of the Contractor, the OWNER may make such payments and shall recover the same from the Contractor's Bills.

26.6 The Contractor shall employ for the Work at the Site only its regular skilled employees with relevant experience. No female labour shall be employed after darkness for the Work at the Site. No person below the age of eighteen years shall be employed by the Contractor for the Work at the Site.

Contractor's Employees:

1. The Contractor shall provide and employ on the site in connection with the execution and maintenance of the works the following:

   a) Technical personnel, skilled and experienced in their respective trades and are competent to give proper supervision to the work they are required to supervise and execute.

   b) Such skilled, semi-skilled and un-skilled labour as is necessary for the proper work strictly as per specification and timely execution and maintenance of the works.

   c) Where required by Applicable Law or Regulation of local or other authority, such personnel shall be duly licensed by the Competent Authority to practice their trades, professions and callings.

   d) The same technical personnel of the Contractor shall continue till completion of Work and if at all it is necessary to withdraw any of the technical personnel of the Contractor to any other site, the same shall be done with the written approval of the Engineer or Owner unless it is a case of resignation.

2. The Contractor shall be responsible for payment of salaries to the said labour/employees. The Contractor shall also be liable to extend/provide all the benefits admissible to said labour/employee under various Applicable Laws in force and as amended from time to time.

3. All traveling expenses including provisions of all necessary transport to and from site, lodging allowances and other payments to the Contractor's employees shall be the sole responsibility of the Contractor.

4. The Contractor's employees shall wear identification badges, safety helmets and applicable protective gear while on working at the Site.

5. All costs, damages or expenses towards any wages or dues to labour or to any Competent Authority under any labour or industrial laws or any other Applicable Law which the Owner may have paid due to act of omission of the Contractor, for which under the Contract the Contractor is liable, may be claimed by the Owner and shall recover the same from the Contractor's Bills.

6. It is expressly agreed by the Parties that on the Contractor's failure to pay any amount due and payable by the Contractor to the Owner under the Contract, including liquidated damages, the Owner shall have the right to recover the same by set-off or deduction against amounts otherwise owing to the Contractor under the Contract, or by drawing against the Contract Performance Guarantee, retainage or any other security provided by the Contractor for performance of its obligations hereunder.

Labour Welfare

a) The Contractor shall provide and maintain such temporary accommodation and amenities as may be reasonably necessary for all its and its Sub-Contractor's staff and labour employed at the Site, including all fencing, water supply (both for drinking and other purposes), electricity supply, sanitation, fire prevention and fire-fighting equipment, air-conditioning and other agreed requirements in connection with such accommodation or amenities.

b) The Contractor shall in all dealings with its and its Sub-Contractors' staff and labour have due regard to all recognized festivals, days of rest and religious or other customs.

c) The Contractor shall at all times take all reasonable precautions to prevent any unlawful riotous or disorderly conduct by or amongst its or its sub-Contractors' staff and labour and for the preservation of peace and protection of persons and property in the neighborhood of the Site against the same.

d) The Contractor shall be responsible for complying with all statutory obligations including without limitation under the following along with the rules and regulations frames there under so long as the same is applicable to the Contractor and the Contractor is bound by them:

a) Apprentices Act, 1961;
b) Building and other construction worker's Act, 1996;
c) Child Labour Act, 1986;
d) Contract Labour Act, 1970,
e) Employment of Children Act, 1938;
f) Employees' State Insurance Act, 1950,
g) Employees' Pension Scheme, 1995;
h) Employees' Provident Funds Act, 1952;
i) ESI Act, 1948;
j) Factories Act, 1948;
k) Fatal Accidents Act, 1855;
m) Industrial Disputes Act, 1947;
n) Industrial Employment Act, 1946;
o) Inter-State Migrant Workmen Act, 1979

p) Maternity Benefit Act, 1961;
q) Minimum Wages Act, 1948;
r) Model Welfare Code;
s) Payment of Bonus Act, 1965;
t) Payment of Gratuity Act, 1972;
u) Payment of Wages Act, 1936;
v) Workman's Compensation Act, 1923;
w) Any other relevant Government of India or State enactments as applicable, for labour and staff engaged in executing this work.

And any amendments thereafter for all the above Acts.

The Contractor shall also keep the Owner indemnified against all claims and disputes arising out of death or injury to their workmen and staff. It will be necessary for the Contractor to ensure that proper safety measures are followed by their workmen to avoid accident, damage, loss to life and property. Approved safety belts must be used by their workmen when working at any height. Charges for the above are deemed to be included in the quoted rates and accepted amount.

As Generating Stations are declared as "Prohibited Place" under the Official Secrets Act, 1923 or other relevant Acts, strict security measures must be followed.

27.0 FACILITIES TO BE PROVIDED BY THE OWNER

27.1 Electricity

The Contractor shall make its own arrangement of construction power and further distribution arrangement; and the provision of temporary lighting and other facilities needed shall be provided by the Contractor.

All temporary wiring must comply with local regulations and shall be subject to the Engineer's inspection/approval before connection to supply. The Owner shall not be responsible for any inconvenience for delay caused due to interruption in power supply and no compensation for such failure or delay in Works on this account can be claimed by the Contractor. The Contractor shall make its own arrangement for alternative source of power supply through deployment of adequate number of DG sets.

27.2 Water

The Contractor shall make its own arrangement of construction water and its further distribution arrangement. The Owner shall not be responsible for any interruption in water supply.

27.3 Communication

The Contractor shall make his own arrangement for all his communication needs such as telephone, facsimile, telex etc at his site office. The Owner shall provide to the Contractor only reasonable assistance in this regard.

27.4 Railway Siding

Existing Railway siding shall be not be available for material/supplies transport etc. Contractor has to plan on its own for movement of ordinary/ODC consignments to plant site.

Further, irrespective of readiness of railway siding, owner reserves the option of coal supply in stockyard before the synchronization of the unit for which Contractor has to ensure readiness of coal supply system up to bunkers.

27.5 **Space**

Any clearing of Site, including jungle cutting levelling, rerouting of inside road / drain, earth excavation, cutting of rocks if any and backfilling, concrete works, main roads to plant buildings required in connection with erection work shall be the Contractor's responsibility. The Contractor, shall provide, if necessary, or if required on the site, all temporary access thereto and shall alter, adapt and maintain the same as required from time to time and shall take up and clear them away as and when no longer required and as and when directed by the Owner and make good all damages done to the site.

The clearance required from Forest Department/any other department shall be to Contractor's account. The Owner shall provide the necessary assistance, if required.

No space will be provided by the Owner for the Contractor's labour inside the power plant area. All facilities for labour housing shall be the sole responsibility of the Contractor.

27.6 **Construction Tools and Equipment:**

The Owner shall not be responsible or held liable for any damage to person or property consequent upon the use, misuse or failure of any construction tools and equipment used by the Contractor or any of its Subcontractors. The acceptance and/or use of any such construction tools and equipment by the Contractor or its Subcontractors shall be construed to mean that the Contractor accepts all responsibilities for and agrees to indemnify and save harmless the Owner from any and all claims for the said damages resulting from the said use, misuse or failure of such construction tools and equipment.

27.7 **Fuel for Startup /Trial Run:**

The fuel (Coal & oil) and limestone as may be required for the initial starting-up/trial run of the plant equipment will be arranged by Owner.

The Owner will ensure that the Owner's Operation & Maintenance Engineers, Operators and other personnel are associated with Contractor's Engineers & Operators during start-up, running and acceptance tests of the plant equipment.

28.0 **FACILITIES TO BE PROVIDED BY THE CONTRACTOR**

28.1 **General Aspects:**

a) Clearing and unloading the equipment from the rail or road transport at Contractor's storage areas and proper stacking there at. Demurrage charges, if incurred at rail head or at site or at dock for default of the Contractor shall be paid by him.

b) Opening of packing cases, inspection and checking of materials. Repair and replacement of contracted material damaged or lost in transit or at

site including lodging of claims to the insurance underwriters under advice to the Owner for such items. Proper store keeping of the plant equipment, if any under the custody of the Contractor in covered storage to be provided in accordance with clause "Material handling and Storage"

c) Final adjustment of foundation levels by chipping and dressing, checking location, elevation etc., of anchor bolts and grouting of anchor bolts and base plates.

d) Complete erection of the equipment covered under the Contract, final preparation for testing, trial run and acceptance tests and putting the plant into satisfactory operation.

e) All consumable stores required for the above work, except those mentioned for Fuel for Start Up and Trial Run.

f) Watch and ward to ensure security and safety of materials under his custody.

g) Residential accommodation for erection labour and other personnel: Owner will not provide any accommodation to Contractor's supervisors' engineers and labourers. Construction of any labour quarter or residential accommodation within the plant boundary shall not be permitted.

h) The Contractor shall employ only competent and skilled workmen fully experienced and capable of performing duties assigned to them. When local laws require, the employees shall be required to acquire certificate of competency for their work from the Competent Authority.

i) All site test facilities including test instruments for site test of equipment, piping, cabling, gauges, insulation testers etc., shall be supplied by the Contractor.

28.2 **Erection and putting into satisfactory operation of Plant and Materials:**

a) Unless otherwise mutually agreed to, the provision of the clause shall apply only where the services for erection of plant and materials supplied by the Contractor are included in the scope of work. The Contractor shall unload all imported/indigenous equipment at Site in areas to be identified by the Owner. The Contractor shall be responsible for complete installation of the equipment, start-up and testing at site, putting into trouble free operation and helping the Owner to carry out performance testing. All equipment and tools for transportation and erection shall be provided by the Contractor. No materials and/or equipment pertaining to the Contract shall be removed from site without the consent in writing of the Owner. The Contractor shall be responsible for obtaining the correct reference lines and levels for purposes of fixing the alignment of various equipment.

b) In the execution of the work no person other than the Contractor, or his appointed representatives, sub-Contractors and workmen shall be allowed to do work at site, except by the special permission in writing of the Owner or his representative, but access to the works at all times shall be accorded to the Owner and his representative and other authorized officials or representatives of the Owner. Nevertheless, the Contractor shall not object to the execution of work by other Contractors or

tradesmen whose names shall have been previously communicated in writing to the Contractor by the Owner, and afford them every facility for the execution of their works simultaneously with his own. The work so far as it is carried out on the Owner's premises shall be carried out at such time as the Owner may approve and so as not to interfere unnecessarily with the conduct of the Owner's business but the Owner shall give the Contractor all reasonable facilities for carrying out the work. No female labour shall be employed after sunset.

The Contractor shall not employ for the purpose of the Contract any person who is below the age of eighteen years and shall pay to each labour, for the work done by such labour, wages not less than the wages paid for similar work as per the provision of Minimum Wage Act, 1948. The Owner shall have the right to enquire into and decide any complaint alleging that the wages paid by the Contractor to any labour for the work done by such labour is less than the wages as per Minimum Wage Act, 1948as in force and amended from time to time, and to refuse appointment of labour less than eighteen years of age. The Contractor shall make regular and prompt payment of wages to the labours engaged on the work and in no case shall the payment be delayed more than seven (7) days following the period for which the wages are due. It if is found that workers are not paid regularly the Contract shall liable to be rescinded. The Contractor shall comply strictly with the provision of labour laws in this respect applicable to the Site.

c) The Contractor shall be required to work under the supervision of the manufacturer's engineers, where the Contractor is not the manufacturer. However, this shall not relieve the Contractor of his responsibility of the correctness or quality of workmanship.

28.3 **Contractor's site office Establishment**

The Contractor shall establish a site office at the site and keep posted an authorized representative for the purpose of the contract, pursuant to GCC.

The Contractor shall, subject to and in accordance with the provisions of the Contract, engineer, procure and deliver the plant and perform such work and services as may be required for the execution of the Works together with all such other things, whether of a temporary or permanent nature, required in connection with the Works in so far as the necessity for providing the same is specified in or reasonably be inferred from the Contract. Without prejudice to the above, the Contractor shall cooperate with the Owner in the coordination of the Works with the work of other sub-Contractors engaged by the Owner, HPGCL, GOH and other persons to whose systems the Facility is to be connected or with whom an interface otherwise exists, provided that such cooperation is reasonably required and shall not unreasonably interfere with the carrying out of the Works.

28.4 **Tools, tackles and scaffoldings**

(i) The Contractor shall provide all the construction equipment, tools, tackles and scaffoldings required for pre-assembly, installation, testing, commissioning and conducting Guarantee tests of the equipment covered under the Contract.

(ii) The Contractor shall provide at his own expense, all the construction equipment, erection tools, machine tools, power tools, tackles, hoists, cranes, derricks, cables, slings, skids, scaffolding, work benches, tools for rigging, cribbing and blocking, welding machines, preheating and stress relieving equipment, X-ray and all associated protection equipment, instruments, appliances, materials and supplies required for unloading, transporting, storing, erection, testing and commissioning that may be required to accomplish the work under the contract. He shall submit a list of all such material to the Owner/Engineer before the commencement of pre-assembly at 'site'. These tools and tackles shall not be removed from the 'site' without the written permission of the Owner/Engineer.

(iii) The Contractor shall also furnish all necessary expandable devices like anchors, grinding and abrasive wheels, hacksaw blades, taps, dies, drills, reamers, chisels, files, carborundum stones, wire brushes, necessary scaffolding, ladders, wooden planks, timbers, sleepers and consumable materials like oxygen, acetylene, argon, lubricating oils, greases, cleaning fluids, graphite powder and flakes, fasteners, gaskets, temporary supports, stainless steel shims of various thickness as required, cotton waste, cheese cloth and all other miscellaneous supplies of every kind required for carrying out the work under the 'contract'.

(iv) The Contractor shall provide all reasonable facilities including tools, personnel, etc and ensure co-ordination with the Owner/Engineer's erection supervisors to enable them to carry out all supervision, measurements, checks etc in a satisfactory manner.

(v) The Contractor shall inform the Owner about arrival of all tools, tackles and scaffoldings. The Contractor shall not dispose or transport or withdraw any tools, tackles, equipment and material provided by him for the 'contract' without taking prior written approval from the Owner/ Engineer; and the Owner/Engineer at all times shall have right to refuse permission for disposal, transport or withdrawal of tools, tackles, equipment and material, if in his opinion, the same will adversely affect the efficient and expeditious completion of the 'Project'.

(vi) The Contractor shall supply with the plant one complete set of all special tools and tackles for the erection, assembly, disassembly, operation and maintenance of the equipment. The Contractor shall furnish a list giving therein the description and quality of each items. The contract price shall include prices of these tools and tackles. These tools and tackles shall be separately packed and delivered to site along with main equipment.

(vii) The Contractor shall also arrange Dozer, Hydra, Cranes, Trailer, Fire Tenders, etc. for the purpose of fabrication, erection and commissioning.

28.5 **Testing Equipment and Facilities**

The contractor shall provide the necessary testing, equipment and facilities.

28.6 **Site laboratory for civil works**

Contractor shall provide and maintain a site laboratory for the testing of construction material under the direction and general supervision of OWNER.

28.7 **First-aid**

The Contractor shall provide necessary first-aid facilities for all his employees, representatives and workmen working at the Site. Enough number of Contractor's personnel shall be trained in administering first-aid.

The OWNER will provide the Contractor, in case of any emergency, the services of an ambulance for transportation to the nearest hospital.

28.8 **Health and Safety Records and Reports**

The Contractor shall maintain such records and make such reports concerning safety, health and welfare of persons at the site and damage to property at the site as the Owner shall from time to time reasonably require consistent with Good Industry Practice. The Contractor shall in any event report to the Owner details of any accident occurring on the site or, if occurring elsewhere, which causes damage to any plant intended for incorporation in the Facility, as soon as reasonably practicable after its occurrence.

Health and Safety Precautions:

Without prejudice to its general obligation to comply with all Indian Laws and Directives concerning health and safety precautions, the Contractor shall at its own cost take all due precautions to ensure the safety of its staff and labour and, in collaboration with and to the requirements of the local health authorities where appropriate, shall ensure that staff with adequate medical training, first aid equipment and stores are available at the Site at all times throughout the period of the contract and that suitable arrangements are made for the prevention of epidemics including all necessary welfare and hygiene requirements. In the event of the outbreak of any illness of an epidemic nature, the Contractor shall comply with and carry out such regulations, orders and requirements of any Competent Authority for the purpose of dealing with an overcoming the same. Safety helmets of a quality specified and/or agreed by the Owner shall be provided by the Contractor for all his staff and labour force, free of charge or cost and it shall be compulsory for such helmet to be worn at all times when on site.

Insects and Pest Nuisance:

The Contractor shall at all times take all reasonably necessary precautions to protect all staff and labour employed on the site from insect nuisance, vermin and other pests and reduce the dangers to health and the general nuisance occasioned by the same.

Radioactive Materials

If there are radioactive isotopes on Site, then radiation workers must have:

a) Undergone a complete medical check-up at the Contractor's cost.

b) Arrangements made for the carrying and inspection of dose meters at the Contractor's cost.

28.9 **Cleanliness and Establishment of Green Belt Area**

The Contractor shall be responsible for keeping the entire area allotted to him clean and free from rubbish, debris etc. during the period of Contract. The Contractor shall employ enough number of special personnel to thoroughly clean his work-area at least once in a day. All such rubbish and scrap material shall be stacked or disposed in a place to be identified by the OWNER. Materials and stores shall be so arranged to permit easy cleaning of the area. In areas where equipment might drip oil and cause damage to the floor surface, a suitable protective cover of a flame resistant, oil proof sheet shall be provided to protect the floor from such damage.

Similarly the labour colony, the offices and the residential areas of the Contractor's employees and workmen shall be kept clean and neat to the entire satisfaction of the OWNER. Proper sanitary arrangements shall be provided by the Contractor, in the work-areas, office and residential areas of the Contractor.

Unless specified in the Scope of Work, the Contractor shall be responsible for planting and maintenance of saplings to provide a green belt area within the boundary to meet the requirements of the Ministry of Environment and Forest.

28.10 **Lubricants and First Fills**

Unless specified in the Scope of Work, the Contractor shall be responsible for, within the contract price, the cost of purchase and delivery to the site of all chemicals, lubricants and other consumables required for the start-up, commissioning, testing and operation of the power plant until final "Taking-Over" and shall ensure that, at final Taking-Over, the quantities of such chemicals, lubricants and other consumables in the tanks, reservoirs, sumps and other points of storage within the works forming part of the power plant are such as to permit the operation of the power Plant after final "Taking-Over". All the first fill and one year's topping requirements or 10% of first fill quantity, whichever is more, at the time of final taking over of the unit which includes but not limited to consumables such as greases, oil, lubricants, servo fluids/ control fluids, gases and essential chemicals etc. which will be required to put the equipment covered under the scope of specifications, into successful commissioning/initial operation and to establish completion of facilities shall be furnished by the bidder. Suitable standard lubricants as available in India are desired. Efforts shall be made to limit the variety of lubricants to minimum.

29.0 **LINES AND GRADES**

29.1 All the Works shall be performed to the lines, grades and elevations indicated on the drawings. The Contractor shall be responsible to locate and layout the Works.

29.2 Basic horizontal and vertical control points will be established and marked by the Owner at Site at suitable points. These points shall be used as datum for the works under the Contract. The Contractor shall inform the Owner well in advance of the times and places at which he wishes to do work in the area allotted to him so that suitable datum points may be established and checked by the Owner to enable the Contractor to proceed with his works. Any work done without being properly located may be removed and/or dismantled by the Owner at Contractor's expense.

30.0 **FIRE PROTECTION**

30.1 The work procedures that are to be used during the erection shall be those which minimize fire hazards to the extent practicable. Combustible materials, combustible waste and rubbish shall be collected and removed from the Site at-least once each day. Fuels, oils and volatile or flammable materials shall be stored away from the construction and equipment and materials storage areas in safe containers. Untreated canvas, paper, plastic or other flammable flexible materials shall not at all be used at Site for any other purpose unless otherwise specified. If any such materials are received with the equipment at the Site, the same shall be removed and replaced with acceptable material before moving into the construction or storage area.

30.2 Similarly corrugated paper fabricated cartons etc. will not be permitted in the construction area either for storage or for handling of materials. All such materials used shall be of water proof and flame resistant type. All the other materials such as working drawings, plans etc. which are combustible but are essential for the works to be executed shall be protected against combustion resulting from welding sparks, cutting flames and other similar fire sources.

30.3 All the Contractor's supervisory personnel and sufficient number of workers shall be trained for fire-fighting and shall be assigned specific fire protection duties. Enough of such trained personnel must be available at the Site during the entire period of the Contract.

30.4 The Contractor shall provide enough fire protection equipment of the types and number for the warehouses, office, temporary structures, labour colony area etc. Access to such fire protection equipment, shall be easy and kept open at all time.

31.0 **SECURITY**

The Contractor shall have total responsibility for all equipment and materials in his custody stores, loose, semi-assembled and/or erected by him at Site. The Contractor shall make suitable security arrangements including employment of security personnel to ensure the protection of all materials, equipment and works from theft, fire, pilferage and any other damages and loss. All materials of the Contractor shall enter and leave the OWNER Site only with the written permission of the OWNER in the prescribed manner.

31.1 **Fencing, Guarding, Lighting etc.**

The Contractor shall be responsible for the proper fencing, guarding, lighting and security of all the works on the site and for the proper provision of temporary roadways, footways, guards and fences on the site as far as may be necessary for the works and so as not to endanger the Owner and occupiers of adjacent property, the public and others all in accordance with Good Industry Practice. In the event that the Contractor is in default of his obligations, the Owner may provide such fencing, guarding, lighting, security, temporary roadways, footways, guards and fences as he may deem necessary and charge the cost thereof to the Contractor.

31.2 **Site Work**

The Contractor shall provide needed apparatus for the use of such supplies of electricity water and other works.

31.3 **Clearance of Site**

On completion of the works, the Contractor shall clear away and remove from the site all surplus materials and, all Contractor's equipment, provided that:

a) Contractor shall give to the Owner the first right of refusal to purchase any surplus materials on the same terms as the Contractor would otherwise have disposed of them to a third party or, if such terms are not readily ascertainable, on such terms as may be reasonable in all the circumstances;

b) Contractor shall, unless otherwise instructed by the Owner, leave on the site for the Owner such temporary works as may be agreed with the Owner. The Contractor shall at all times keep the site and the Facility in a clean, safe and workman like condition and shall dispose of all rubbish (other than hazardous materials or other materials which may contaminate ground water, for which other arrangements shall be made) in a properly prepared landfill site in accordance with Good Industry Practice.

31.4 **Materials obtained from Excavation**

Materials of any kind obtained from excavation on the Site shall remain the property of the Owner and shall be disposed of as the Engineer in-Charge may direct.

31.5 **Treasure, Trove, Fossils, etc**

All fossils, coins, articles of value or antiquity and structures and other remains or things of geological or archaeological interest discovered on the Site shall be the absolute property of the Owner and the Contractor shall take reasonable precautions to prevent his workmen or any other person from removing or damaging any such article or thing, shall immediately upon discovery thereof and before removal acquaint the Engineer in Charge with such discovery and carry out the Engineer in Charge's directions as to the disposition of the same, at the cost of the Owner.

31.6 **Protection of Trees**

Trees shall be protected from damage during the course of the Works and earth level within at least one (1) M of each such tree shall not be disturbed. Where necessary, such trees shall be protected by providing temporary fencing at the cost of the Owner.

31.7 **Prevention of Pollution**

The Contractor shall make necessary arrangement to prevent pollution of the water in any adjacent water bodies including stream, springs, nallah, river and lakes etc. The Contractor shall be solely responsible and liable for all damage caused by any pollution that may take place during the execution of the Work.

32.0 **CONTRACTOR'S AREA LIMITS**

The Owner will mark-out the boundary limits of access roads, parking spaces, storage and construction areas for the Contractor and the Contractor shall not trespass the areas not so marked out for him. The Contractor shall be responsible to ensure that none of his personnel move out of the areas marked out for his operations. In case of such a need for the Contractor's personnel to work out of the areas marked out for him the same shall be done only with the written permission of the Owner.

Necessary barricading of the existing facilities from the construction area, to avoid any interference.

The height of barricading shall not be less than 30 feet. For the construction, material handling and labour movement for the packages which are interlinked with the existing plant facilities, necessary permission be taken by the Contractor in order to avoid infringement with the operation/ Generation of the existing Units.

33.0 **CONTRACTOR'S CO-OPERATION WITH THE OWNER**

33.1 The Contractor shall cooperate with the Owner's other sub-Contractors and Engineers for associated equipment and freely exchange with them such technical information as is necessary to obtain the most efficient and economical design and to avoid unnecessary duplication of equipment. No remuneration shall be claimed from the Owner for such technical cooperation. The Owner/Engineer shall be provided with copies each of all correspondence addressed by the Contractor to the other Contractors with respect to such exchanges of technical information.

33.2 If any part of the Contractor's work depends for proper execution or results, upon the work of any other Contractor, the Contractor shall inspect and promptly report in writing to the Owner any defects in such works that render it unsuitable for such proper execution and results. His failure to so inspect and report shall constitute an acceptance of the other sub-Contractor's work as fit and proper for the reception of his work, except as to defects which may develop in the other Contractor's work after the proper execution of his work.

33.3 In case where the performance of the erection work by the Contractor affects the operation of the system facilities of the OWNER, such erection work of the Contractor shall be scheduled to be performed only in the manner stipulated by the OWNER and the same shall be acceptable at all times to the Contractor. The OWNER may impose such restrictions on the facilities provided to the Contractor such as electricity, etc. as he may think fit in the interest of the OWNER and the Contractor shall strictly adhere to such restrictions and co-operate with the OWNER. It will be the responsibility of the Contractor to provide all necessary temporary instrumentation and other measuring devices required during start-up and operation of the equipment systems which are erected by him. The Contractor shall also be responsible for flushing and initial filling of all the oil and lubricants required for the equipment furnished and installed by him, so as to make such equipment ready for operation. The Contractor shall be responsible for supplying such flushing oil and other lubricants unless otherwise specified elsewhere in documents and specifications.

34.0 PRE-COMMISSIONING AND COMMISSIONING ACTIVITIES

34.1 GENERAL

34.1.1 The Contractor upon completion of installation of equipments and system shall conduct pre-commissioning and commissioning activities, to make the equipment/systems ready for safe, reliable and efficient operation on sustained basis. All pre-commissioning/commissioning activities considered essential for such readiness of the equipment/systems including those mutually agreed and as well as those indicated in clauses elsewhere in the technical specifications shall be performed by the Contractor.

34.1.2 The pre-commissioning and commissioning activities including Guarantee tests, checks and trial operations of the equipment / systems furnished and installed by the Contractor shall be the responsibility of the Contractor as detailed in relevant clauses in Technical Specification. The Contractor shall provide, in addition, test instruments, calibrating devices etc. and labour required for successful performance of these operations. If it is anticipated that the above test may prolong for a long time, the Contractor's workmen required for the above test shall always be present at site during such operations.

34.1.3 The following activities shall be carried out by the Contractor, twelve (12) months prior to schedule date of commissioning of the equipment/systems installed by him.

a) The Contractor shall furnish the organization chart of his operation and commissioning engineers for the acceptance of Owner. Adequate number of operation and commissioning engineers shall be deployed by the Contractor to effectively meet the requirement of round the clock operation in shifts also, till the plant is taken over by the Owner.

b) The Contractor shall submit the bio-data containing the details of experience of his operation and commissioning engineers for the acceptance of Owner.

c) The Contractor shall furnish the deployment schedule of his operation and commissioning engineers for the acceptance of the Owner.

d) Apart from above, Contractor shall ensure deployment of sufficient killed/semi-skilled/unskilled manpower during pre-commissioning and commissioning activities.

34.1.4 It shall be the responsibility of the Contractor to provide all necessary temporary instrumentation and other measuring devices required during start-up and initial operation of the equipment/systems which are installed by him.

34.1.5 The Contractor shall also be responsible for flushing and initial filling of all oils and lubricants required for the equipment furnished and installed by him so as to make such equipment ready for operation. The Contractor shall be responsible for supplying such flushing oil and other lubricants unless otherwise specified elsewhere in the specifications and documents.

34.2 **Commissioning Documentation**

34.2.1 The Contractor shall submit the commissioning documentation, comprising of Standard checklists, pre-commissioning procedures, testing schedules, commissioning schedules and commissioning networks for various equipment /systems covered under the contract, for the approval of Owner.

34.2.2 Standard checklist, as the name suggests, shall be a fairly general documents, containing the list of all checks required to be carried out for similar and repetitive type of equipment to ensure consistent and thorough checking. An indicative list of such equipment is enclosed as Annexure-I.

34.2.3 The testing schedule is a document, designed for safe and systematic commissioning of individual equipment/sub-system (for example Boiler Feed Pump, condensate pump, compressor etc.) commissioning schedule is a document envisaged for commissioning of a system (for example feed system, Condensate system, Compressed Air System ,Fire water system, Unit commissioning etc.). The testing/commissioning schedule shall have a standard format in order to maintain consistency of presentation, content and reporting. A brief write upon the contents of the Testing Schedule/Commissioning Schedule is enclosed as Annexure-II.

34.2.4 The Contractor shall submit the list of commissioning documentation to be submitted by him, along with their submission schedule for various equipment/systems covered under the contract, within six (6) months from the date of award of contract, for the acceptance of Owner.

34.2.5 The Contractor shall submit the commissioning documentation, for various equipment covered under the contract, for the approval of Owner at least twelve (12) months before the scheduled date of commissioning of the equipment / systems.

34.3 **Commissioning Activities**

34.3.1 Upon completion of pre-commissioning activities/ tests, the contractor shall initiate commissioning of facilities. During commissioning the Contractor shall carryout system checking and reliability trails on various parts of the facilities.

34.3.2 Contractor shall carry out the checks /tests at site to prove to the Owner that each equipment of the supply complies with requirements stipulated and is installed in accordance with requirements specified.

34.3.3 Before the plant is put into initial operation the Contractor shall be required to conduct test to demonstrate to the Owner that each item of the plant is capable of correctly performing the functions for which it was specified and its performance, parameters etc. are as per the specified / approved values. These tests may be conducted concurrently with those required under commissioning sequence.

34.3.4 The Contractor shall also demonstrate the performance of all C&I equipment, the tests on main equipment of prior to that as the case may be.

34.3.5 Other tests shall be conducted, if required by the Owner, to establish that the plant equipment is in accordance with requirements of the specifications.

34.3.6 The Contractor shall conduct all the commissioning tests and undertake commissioning activities pertaining to all other auxiliaries and equipment including all electrical and C&I equipment / systems not specifically brought out above but are within the scope of work and facilities being supplied and installed by the Contractor and follow the guidelines indicated above or else wherein these technical specifications.

34.4 **Initial Operation**

Upon completion of system checking/Tests as above and as a part of commissioning of facilities, complete facilities/Plant shall be put on initial operation as stipulated in SCC clause 5.0.

35.0 **MATERIALS HANDLING AND STORAGE**

35.1 All the equipment furnished under the Contract and arriving at Site shall be promptly received, unloaded and transported and stored in the storage spaces by the Contractor.

35.2 Contractor shall be responsible for examining all the shipment and notify the OWNER immediately of any damage, shortage, discrepancy etc. for the purpose of OWNER's information only. The Contractor shall submit to the OWNER every week a report detailing all the receipts during the week. However, the Contractor shall be solely responsible for any shortages or damage in transit, handling and/or in storage and erection of the equipment at Site. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.

35.3 The Contractor shall maintain an accurate and exhaustive record detailing out the list of all equipment received by him for the purpose of erection and keep such record open for the inspection of the OWNER.

35.4 All equipment shall be handled very carefully to prevent any damage or loss. No bare wire ropes, slings, etc. shall be used for unloading and/or handling of the equipment without the specific written permission of the OWNER. The equipment stored shall be properly protected to prevent damage either to the equipment or to the floor where they are stored. The equipment from the store shall be moved to the actual location at the appropriate time so as to avoid damage of such equipment at Site.

35.5 All electrical panels, controls gear, motors and such other devices shall be properly dried by heating before they are installed and energized. Motor bearings, slip rings, commutators and other exposed parts shall be protected against moisture ingress and corrosion during storage and periodically inspected. Heavy rotating parts in assembled conditions shall be periodically rotated to prevent corrosion due to prolonged storage.

35.6 All the electrical equipment such as motors, generators, etc. shall be tested for insulation resistance at least once in three months from the date of receipt till the date of commissioning and a record of such measured insulation values shall be maintained by the Contractor. Such records shall be open for inspection by the OWNER.

35.7 The Contractor shall ensure that all the packing materials and protection devices used for the various equipment during transit and storage are removed before the equipment are installed.

35.8 The consumables and other supplies likely to deteriorate due to storage must be thoroughly protected and stored in a suitable manner to prevent damage or deterioration in quality by storage.

35.9 All the materials stored in the open or dusty location must be covered with suitable weather proof and flame-proof covering material wherever applicable.

35.10 If the materials belonging to the Contractor are stored in areas other than those earmarked for him, the OWNER will have the right to get it moved to the area ear marked for the Contractor at the Contractor's cost.

35.11 The Contractor shall be responsible for making suitable indoor storage facilities to store all equipment which require indoor storage. Normally, all the electrical equipment such as motors, control gear, generators, exciters and consumables like electrodes, lubricants etc. shall be stored in the closed storage space. The OWNER, in addition, may direct the Contractor to move certain other materials, which in his opinion will require indoor storage, to indoor storage areas which the Contractor shall strictly comply with.

35.12 Sound Storage Management system need to be followed for storage of material. First in First Out method (FIFO) to be adopted to avoid longtime storage. Storage duration of any material at site shall not be more than 3 months. Accordingly supply of material in sequence of erection at site to be ensured. To achieve the same, following is to be adopted:

a. Dispatch clearance is to be given in order of sequence of erection. To achieve the goal, proper tags shall be maintained in ascending order. The tag shall be self-explanatory.

b. MDCC shall be issued by RIO based on clearance from Site FQA head, Main contractor, Erection head for dispatch and supply of material. Strict adherence to sequential supply of material as per supply schedule.

An automated storage and retrieval system consists of a variety of computer-controlled systems for automatically placing and retrieving of material may be adopted. Accordingly, each material shall be marked with unique identification code.

36.0 CONSTRUCTION MANAGEMENT

36.1 The field activities of the Contractors working at Site, will be coordinated by the Owner and the Owner decision shall be final in resolving any disputes or conflicts between the Contractor and other Contractors and tradesmen of the Owner regarding scheduling and co-ordination of work. Such decision by the Owner shall not be a cause for extra compensation or extension of time for the Contractor.

36.2 The Owner shall hold weekly meetings of all the Contractors working at Site, at a time and place to be designated by the Owner. The Contractor shall attend such meetings and take notes of discussions during the meeting and the decisions of the Owner and shall strictly adhere to those decisions in performing his Works. In addition to the above weekly meeting, the Owner may call for other meeting either with individual Contractors or with selected number of Contractors and in such a case the Contractor if called, will also attend such meetings.

36.3 Time is the essence of the Contract and the Contractor shall be responsible for performance of his works in accordance with the specified construction schedule. If at any time, the Contractor is falling behind the schedule, he shall take necessary action to make good for such delays by increasing his work force or by working overtime or otherwise accelerate the progress of the work to comply with the schedule and shall communicate such actions in writing to the Owner, satisfying that his action will compensate for the delay. The Contractor shall not be allowed any extra compensation for such action.

36.4 The Owner shall however not be responsible for provision of additional labour and/or materials or supply or any other services to the Contractor except for the coordination work between various Contractors as set out earlier.

36.5 **Site management during construction phase till Final Taking Over of Plant**

Contractor shall ensure that the plant site within the plant boundary is managed in a coordinated and professional way all through the construction phase till Final Taking over of plant, ensuring safe, easy & unhindered working conditions and a healthy & hygienic working environment at site. He shall ensure the following measures at site while executing the project.

a) Unhindered motorable road access to all work areas and facilities both during the construction/erection and as they get completed progressively. Required temporary access roads other than the permanent roads shall also be provided. Contractor shall prioritize the construction of approach roads, roads around the main plant block, roads to office & storage areas and the offsite areas from the start of project itself. He shall finalize and submit the complete road layout plan along with priority and completion schedule immediately after the award for review by the Owner. He shall ensure that the roads are promptly repaired and maintained against any damages due to movement of traffic/heavy trailers & cranes etc. providing motorable access at all times. Adequate onsite stock of road materials shall be kept and maintained disturbed over the site for repairs especially before the monsoon period.

b) Proper drainage of rain water, ground water from excavations, water flows from batching plant/construction sites etc. He shall prioritize the construction of permanent drains from the start of the project itself. Till such time the permanent drainage network is done, he shall construct adequate temporary drains to ensure that there is no accumulation /stagnation of water in the plant site. Contractor may consider providing pre-cast RCC drains for temporary/permanent drain construction for faster construction of drains. The drain construction shall be matched with progress of road construction for preventing damage to roads. Contractor shall provide and maintain adequate number of drainage pumps (both electrical and diesel operated) of suitable capacity for pumping out accumulated water especially during the monsoon periods. All drain diversions required shall be undertaken at the start of the project itself.

c) The plant site is fully secured against unauthorized access.

d) Proper housekeeping by systematic and proper disposal of earth from excavations(separately for usable & surplus earth), muck (from pile bores or otherwise), wastes (from dismantling of pile tops, concrete works etc),

packing & insulation wastes, steel scrap, cable wastes etc generated during construction / erection works. Suitable disposal sites for each of above shall be identified in the layout and at site in the beginning of the project itself. It shall be ensured that all agencies engaged by the Contractor follow the discipline to dispose off of earth spoils and wastes at the designated places. Preferably once in a week suitable time slot will be identified for housekeeping by all agencies and suitable instructions shall be issued in this regard. Contractor may engage a separate agency or identify a gang for collection of wastes and disposal to designated places. Suitable arrangement / tie-up will also be made for periodic disposal of wastes/ scrap from the designated places.

e) All fabrication areas shall be suitably hard crusted to provide water free and proper working platforms. Suitable sheds preferably pre-engineered structures to be provided for paint shops, fabrication workshops etc for ensuring all weather work conditions for onsite structural works. For the main plant and auxiliary buildings, Contractor should preferably plan the works in such a way that structural fabrication is done in suppliers offsite works/workshops and onsite fabrication works are avoided/kept minimum.

f) Suitable onsite maintenance workshop for day-to-day breakdown maintenance heavy plant and equipment like batching plants, cranes, earth moving equipment, welding equipment etc. The workshop shall have stock of frequently needed spares and suitable repair facilities with experienced technicians/mechanics. A central test laboratory equipped with test equipment for routine tests like tests on soil, concrete, bricks, aggregates, welds etc., with experienced staff shall be established at the start of the project itself.

g) All office and covered store buildings of the contractor and its agencies shall be of prefab/pre-engineered/porta cabin construction. Shabby semi-finished constructions in brickwork/GI/asbestos roof etc., shall not be permitted.

h) First aid facilities and amenities like rest rooms, suitable pre-engineered toilets (separate for men and women), drinking water fountains/tanks, canteen, crèche for women workers shall be planned and established at the beginning of the project itself. These facilities shall be distributed over the plant area to enable easy access by the construction workers and staff and shall be marked on the plant layout. Suitable treatment for toilet discharge, like bio digesters etc shall be planned and conventional septic tanks / soak pits etc., shall be avoided.

i) Proper lighting of all construction / erection areas. Contractor shall erect adequate number of high lighting masts in main plant, offsite, office and store areas for lighting during night. DG sets of adequate capacity shall be provided for emergency backup. The street lighting along the roads shall also be prioritized along with road construction. The construction power ring main shall be planned and erected immediately after the award.

j) Well planned and coordinated storage and movement of plant, equipment and construction materials. System wise / agency wise storage / lay down areas shall be planned and marked on the plant layout at the beginning itself. Contractor shall ensure that all its agencies comply to the areas allocated to them and follow the designated storage and movement plans. Adequate covered storage shall be constructed for storage of critical equipment like switchgears, MCCs, insulation etc.

k) Proper access control for construction workers, staff and visitors. Contractor shall ensure that suitable electronic based gate pass system is in place from start of project itself to keep record and track of all workers, staff and visitors entering/exiting the plant premises shift wise on daily basis.

l) Compliance to all safety requirements as specified in this document. Contractor shall establish a safety center at the start of the project itself. It shall have a 24X7 manned safety control room in addition to a permanent safety equipment display room, separate training / lecture hall with AV facilities for safety training, store room with adequate stock of specified safety equipment, a first aid room and other amenities. Contractor shall install 25 Nos. CCTV cameras or more as per site requirement at all strategic locations in the plant area which shall be linked to the safety control room."

m) Compliance to all environment and other conditions stipulated by the concerned statutory authorities while according clearance / NOC (No objection certificate) to the project. Contractor shall ensure adequate sprinkling of water by deploying water tankers to prevent the fugitive dust nuisance during construction.

n) Development of suitable landscape & green belt areas and rainwater harvesting within the plant premises. Contractor shall plan to develop the landscape & green belt areas and rainwater harvesting from the start of the project itself. The landscape and rain water harvesting plan shall be finalized immediately after award of work and suitable work plan with priority and schedule shall also be finalized thereafter. Top soil before excavation shall be suitably preserved and stacked for landscape and green belt development.

o) Provision of adequate shelters, water supply, sanitation and lighting in construction workers and staff camps. No camps for workers and staff shall be permitted within the plant premises and contractor shall make separate arrangement outside the plant premises for locating and development of camps for construction workers and staff. The designated areas shall be suitably developed with infrastructure like roads, drains, water supply and sewerage and shall be free from water logging. Suitable low cost shelters will be provided for the workers. Complete area shall be secured by fencing and shall be provided adequate area lighting. Suitable waste disposal, shopping and recreation facilities will be developed in these camps. Contractor shall ensure that due importance is given to site management as discussed above and a detailed work plan considering the above aspects is finalized immediately after the award. A senior level executive shall be identified who shall be responsible for implementation of the work plan. Suitable format for progress reporting on site management plan shall be developed and made part of the project progress report. The progress on implementation of above work plan shall be reviewed along with project progress in the monthly project review meetings with Owner. In case the progress on site management plan is unsatisfactory, Owner may withhold up to 1% of the monthly running bill (for civil and site erection works) till such time the required progress is demonstrated. In case in the opinion of Owner, contractor's actions on site management aspects is not adequate, Owner may get the relevant work executed through a separate agency at the risk and cost of the Contractor.

37.0 **FIELD OFFICE RECORDS**

The Contractor shall maintain at his Site Office up-to-date copies of all drawings, specifications and other Contract Documents and any other supplementary data complete with all the latest revisions thereto. The Contractor shall also maintain in addition the continuous record of all changes to the above Contract Documents, drawings, specifications, supplementary data, etc. effected at the field and on completion of his total assignment under the Contract shall incorporate all such changes on the drawings and other Engineering data to indicate as installed conditions of the equipment furnished and erected under the Contract. Such drawings and Engineering data shall be submitted to the Owner in required number of copies.

38.0 **CONTRACTOR'S MATERIALS BROUGHT ON TO SITE**

38.1 The Contractor shall bring to Site all equipment, components, parts, materials, including construction equipment, tools and tackles for the purpose of the Works under intimation to the OWNER. All such goods shall, from the time of their being brought vest in the OWNER, but may be used for the purpose of the Works only and shall not on any account be removed or taken away by the Contractor without the written permission of the OWNER. The Contractor shall nevertheless be solely liable and responsible for any loss or destruction thereof and damage thereto.

38.2 The OWNER shall have a lien on such goods for any sum or sums which may at any time be due or owing to him by the Contractor, under, in respect of or by reasons of the Contract. After giving a fifteen (15) days notice in writing of his intention to do so, the OWNER shall be at liberty to sell and dispose off any such goods, in such manner as he shall think fit including public auction or private treaty and to apply the proceeds in or towards the satisfaction of such sum or sums due as aforesaid.

38.3 After the completion of the Works, the Contractor shall remove from the Site under the direction of the OWNER the materials such as construction equipment, erection tools and tackles, scaffolding etc. with the written permission of the OWNER. If the Contractor fails to remove such materials, within fifteen (15) days of issue of a notice by the OWNER to do so then the OWNER shall have the liberty to dispose of such materials as detailed under as specified above and credit the proceeds thereto to the account of the Contractor.

38.4 **Transportation:**

The Contractor shall at its own risk and expense transport all the Plant and Equipment and the Contractor's Equipment to the Site by the mode of transport that the Contractor judges most suitable under all the circumstances. Unless otherwise provided in the Contract, the Contractor shall be entitled to select any safe mode of transport by any person to carry the Plant and Equipment and the Contractor's Equipment. Upon dispatch of each shipment of the Plant and Equipment and the Contractor's Equipment, the Contractor shall notify the Owner by courier, post, by telefax or by EDI followed by post confirmation of the description of the Plant and Equipment and of the Contractor's Equipment, the point and means of dispatch, and the estimated time and point of arrival in the country where the Site is located, if applicable, and at the Site. The Contractor shall furnish the Owner with relevant shipping documents to be agreed upon between the parties.

The Contractor shall be responsible for obtaining, if necessary, approvals from the authorities for transportation of the Plant and Equipment and the Contractor's Equipment to the Site. The Owner shall use its best endeavors in a timely and expeditious manner to assist the Contractor in obtaining such approvals, if requested by the Contractor. The Contractor shall indemnify and hold harmless the Owner from and against any claim for damaged to roads, bridges or any other traffic facilities that may be caused by the transport of the Plant and Equipment and the Contractor's Equipment to the Site.

Customs Clearance: The Contractor shall, at its own expense, handle all imported Plant and Equipment including spares and Contractor's Equipment at the point(s) of import and shall handle all formalities for customs clearance, including liability for port charges etc.

After the completion of the works, the Contractor shall remove from the site under the direction of the Engineer, the materials such as construction equipment, erection tools and tackles, scaffolding, etc with the written permission of the Engineer. If the Contractor fails to remove such materials, within fifteen (15) days of a notice by the Engineer to do so, then the Engineer shall have the liberty to dispose of such materials as detailed in above clause and credit the proceeds thereof to the account of the Contractor.

39.0 PROTECTION OF PROPERTY AND CONTRACTOR'S LIABILITY

39.1 The Contractor shall be responsible for any damage resulting from his operations. He shall also be responsible for protection of all persons including members of public and employees of the OWNER and the employees of other Contractors and Sub-Contractors and all public and private property including structures, building, other plants and equipment and utilities either above or below the ground.

39.2 The Contractor will ensure provision of necessary safety equipment such as barriers, sign-boards, warning lights and alarms, etc. to provide adequate protection to persons and property. The Contractor shall be responsible to give reasonable notice to the OWNER and the owners of public or private property and utilities when such property and utilities are likely to get damaged or injured during the performance of his Works and shall make all necessary arrangements with such owners, related to removal and/or replacement or protection of such property and utilities.

40.0 PAINTING

For painting, refer Volume II, Chapter 7.

Painting for piping shall also conform to the painting specification of respective chapters.

Painting for Electrical equipment/systems shall conform to the painting specification given in Volume IV.

41.0 INSURANCE

41.1 In addition to the conditions covered under the Clause entitled "Insurance" in Section-IV – General Conditions of Contract (GCC) the following provisions shall also apply to the portion of works to be done beyond the Contractor's own or his Sub-Contractor's manufacturing Works.

The Comprehensive insurance of Contractor's/Subcontractors' equipment during erection and commissioning, Workmen's Compensation Insurance, Comprehensive Automobile Insurance and Comprehensive General Liability Insurance shall be the responsibility of the Contractor until Final Taking Over of the Plant.

41.2 **Workmen's Compensation Insurance**

This insurance shall protect the Contractor against all claims applicable under the Workmen's Compensation Act, 1948 (Government of India). This policy shall also cover the Contractor against claims for injury, disability disease or death of his or his Sub- Contractor's employees, which for any reason are not covered under the Workmen's Compensation Act, 1948. The liabilities shall not be less than the following:

Workmen's Compensation	-	As per Statutory Provisions
Employee's Liability	-	As per Statutory Provisions

41.3 **Comprehensive Automobile Insurance**

This insurance shall be in such a form to protect the Contractor against all claims for injuries, disability, disease and death to members of public including the OWNER's men and damage to the property of other arising from the use of motor vehicles during on or off the Site operations, irrespective of the Ownership of such vehicles. The liability covered shall be as herein indicated or as per the statutory requirement, whichever is higher:

Fatal Injury	:	Rs.200,000 each person
	:	Rs.400,000 each occurrence
Property Damage	:	Rs.500,000 each occurrence

41.4 **Fire Insurance**

Unless otherwise instructed by the Owner/Engineer, the Contractor shall, on signing the 'contract', insure the works and keep them insured until the completion of the 'contract' against loss or damage by fire, with the Company to be approved by the Owner/Engineer, in the joint names of the Owner and the Contractor for such amount and for any further sum, if called upon to do so by the Owner/Engineer, the premium of such further sum being allowed to the Contractor as an authorized extra. Such policy shall cover the property of the Owner only and shall not cover any property of the Contractor or any Subcontractor, or his employees. The Contractor shall deposit the policy receipts for the premium with the Owner/Engineer within twenty one (21) days from the date of signing the 'contract' unless otherwise instructed by the Owner/Engineer. In default of the Contractor insuring as provided above, the Owner may so insure and may deduct the premiums paid from any moneys due, or which may become due to the Contractor. The Contractor shall, as soon as the claim under the policy is settled, or the work reinstated by the Insurance Office should they elect to do so, proceed with all due diligence with the completion of the works in the same manner as though the fire had not occurred and in all respects under the same conditions of 'contract'. The Contractor shall arrange all the replacement materials damaged during fire accident if any without for finalization of his claim with insurance company. The claim received if any will be passed on to the Contractor.

The Owner may consider to exclude the total insurance cover responsibility from the Contractor's scope. However, the Contractor shall furnish the detailed price break-up of insurance in the price schedule. The insurance coverage and payment for insurance shall be as per the new insurance regulations and subjected to RBI regulations as erection cum storage insurance may not be permitted to be covered through the foreign company.

41.5 **Comprehensive General Liability Insurance**

41.5.1 The insurance shall protect the Contractor against all claims arising from injuries, disabilities, disease or death of members of public or damage to property of others, due to any act or omission on the part of the Contractor, his agents, his employees, his representatives and Sub-Contractors or from riots, strikes and civil commotion. This insurance shall also cover all the liabilities of the Contractor arising out of the Clause entitled "Defense of Suits" in Section General Conditions of Contract (GCC).

41.5.2 The hazards to be covered shall pertain to all the Works and areas where the Contractor, his Sub-Contractors, his agents and his employees have to perform work pursuant to the Contract.

41.5.3 The above are only illustrative list of insurance covers normally required and it will be the responsibility of the Contractor to maintain all necessary insurance coverage to the extent both in time and amount to take care of all his liabilities either direct or indirect, in pursuance of the Contract.

42.0 **UNFAVOURABLE WORKING CONDITIONS**

The Contractor shall confine all his field operations to those works which can be performed without subjecting the equipment and materials to adverse effects during inclement weather conditions, like monsoon, storms, etc. and during other unfavorable construction conditions. No field activities shall be performed by the Contractor under conditions which might adversely affect the quality and efficiency thereof, unless special precautions or measures are taken by the Contract or in a proper and satisfactory manner in the performance of such Works and with the concurrence of the OWNER. Such unfavorable construction conditions will in no way relieve the Contractor of his responsibility to perform the Works as per the schedule.

No extension of time of any account shall be given to the Contractor on account of unfavorable working conditions.

43.0 **PROTECTION OF MONUMENTS AND REFERENCE POINTS**

The Contractor shall ensure that any finds such as relic antiquity, coins, fossils, etc. which he may come across during the course of performance of his Works either during excavation or elsewhere, are properly protected and handed over to the Owner. Similarly the Contractor shall ensure that the benchmarks, reference points, etc. which are marked either with the help of Owner or by the Owner shall not be disturbed in any way during the performance of his Works. If, any work is to be performed which disturb such reference, the same shall be done only after these are transferred to other suitable locations under the direction of the Owner. The Contractor shall provide all necessary materials and assistance for such relocation of reference points etc.

44.0 WORK & SAFETY REGULATIONS

44.1 General

i) The contractor shall comply with all the requirements of "The Building and Other Construction Workers (Regulation of Employment & Conditions of Service) Act," 1996 and its Central Rule 1998 / State Rules, CEA Regulations on Safety Requirements (2011) and any other statutory requirements as applicable.

ii) The Contractor shall follow OWNER Safety Rules as issued from time to time with respect to safety in construction & erection.

iii) The contractor shall have the approved Safety, Health and Environment (SHE) Policy in respect of Safety and health of Building Workers and it shall be circulated widely and displayed at conspicuous place in Hindi and local language understood by the majority of the workers. A copy of the safety policy should be submitted to Engineer-in- charge.

iv) The contractor shall submit the safety plan comprising of methods to implement the Safety Policy/ Rules, Risk assessment and ensuring Safety at work areas, Safety audits, inspections and its compliance, Supervision and responsibility to ensure Safety at various levels, Safety training to employees, review of Safety and accident analysis, ensure Health and Safety Procedures to prevent accidents to Engineer I/C for approval. The typical format of Safety plan as annexed at Annexure - III. The Contractor shall also comply to the CEA Regulation on Safety Requirements, 2011.

v) The Contractors shall ensure proper safety of all the workmen, materials, plant and equipment belonging to him or to the OWNER or to others, working at the Site.

vi) All equipment used in construction and erection by the contractor shall meet BIS / International Standards and where such standards do not exist, the Contractor shall ensure these to be absolutely safe. All equipment shall be strictly operated and maintained by the contractor in accordance with manufacturer's operation manual. The contractor should also follow Guidelines / Rules of the OWNER in this regard.

vii) The Contractors shall provide suitable latest Personal Protective Equipment of prescribed standard to all their employees and workmen according to the need. The Engineer I/C shall have the right to examine these safety equipment to determine their suitability, reliability, acceptability and adaptability. The contractor should also ensure these before their use at work site.

viii) The Contractor shall provide safe working conditions to all workmen and employees at his workplace including safe means of access, railings, stairs, and ladders, scaffolding, work platforms, toe boards etc. The scaffoldings shall be erected under the control and

supervision of an experienced and competent person. For erection of scaffolds, access, work platforms etc. shall be good and the contractor shall use standard quality of material.

ix) The Contractor shall follow and comply with all the Safety Rules, standards, code of practices of OWNER and relevant provisions of applicable laws pertaining to the safety of workmen, employees, plant and equipment as may be prescribed from time to time without any protest or contest or reservation. In case of any unconformity between statutory requirement and the Safety Rules of the OWNER referred above, the latter shall be binding on the Contractor unless the statutory provisions are more stringent. As and when required he can refer/obtain copy of OWNER safety documents as stated above.

x) The contractor shall have his own arrangements with near by hospitals for shifting and treatment of sick and injured.

The medical examination of the workers employed in hazardous areas shall be conducted as per Rule 223 of The Building and Other Construction Worker (Regulation of Employment and Condition of Service) Central Rule 1998 their health records shall be maintained accordingly and to be submitted to Engineer I/C when asked for. If any worker found suffering from occupational health hazard, the worker should be shifted to suitable place of working and properly treated under intimation to Engineer I/C. The medical fitness Certificate to be submitted to Engineer (I/C).

xi) First Aid boxes equipped with requisite articles as specified in the Rule 231 of The Building and Other Construction Worker (Regulation of Employment and Condition of Service) Central Rule 1998 shall be provided at construction sites for the use of workers. Training has to be provided on first aid to workmen & office bearers working at site.

44.2 **Emergency Action Plan**

The contractor shall prepare an emergency action plan approved by his competent authority to handle any emergency occurred during construction work. Regular mock drills shall be organized to practice this emergency plan. The Emergency Action Plan should be widely circulated to all the employees and suitable infrastructure shall be provided to handle the emergencies.

44.3 **Scaffolding**

The contractor shall take all precautions to prevent any accidental collapse of scaffolding or fall of persons from scaffolding. The contractor should ensure that scaffolding are designed by a competent person and it erection and repairs should be done under the expert supervision. The scaffolding shall meet the required strength and other requirements for the purpose for which the scaffold is erected. The material used for scaffold should conform to the BIS/ International standards.

44.4 **Opening**

The contractor shall ensure that the opening in any working platform/any floor of the building which may cause fall of workers or material. Whenever an opening on a platform/any floor of the building is unavoidable, the opening should be suitably fenced and necessary measures for protection against falling objects or building workers from such platform are taken by providing suitable safety nets, safety belts or other similar means.

44.5 **Explosives**

The contractor shall take all precautions while handling, using, storing or transporting of all explosives. Before usage of any explosive, necessary warning/danger signals be erected at conspicuous places to warn the workers and general public. The contractor should strictly ensure that all measures and precautions required to be complied for use, handling, storing or transportation of explosives under the rules framed under the Explosives Act, 1884.

44.6 **Fencing of Machinery**

The contractor shall provide suitable fencing or guard to all dangerous and moving parts of machinery.

The contractor shall not allow any of the employees to clean, lubricate, repair, adjust or examine during machinery in motion, which may cause injury to the person.

44.7 **Carrying of Excessive Weight by a Worker**

The worker shall not be allowed to lift by hand or carry over his head back or shoulder more than the maximum limit set by the prescribed rules for the construction Workers.

44.8 **Dangerous and Harmful Gases/Equipment**

The contractor shall ensure that the workers are not exposed to any harmful gases during any construction activity including excavation, tunneling, confined spaces, etc.

The contractor should not allow any worker to go into the confined space unless it is certified by Engineer (I/C) to be safe and fit for the entry to such work place. Proper record and work permits should be followed to carry out such works.

44.9 **Over head Protection**

The contractor shall ensure that any area exposed to risk of falling materials, articles or objects is roped off or cordoned off or otherwise suitably guarded from inadvertent entry of any person.

Wherever there is a possibility of falling of any material, equipment or construction workers while working at heights, a suitable and adequate safety net should be provided. The safety net should be in accordance with BIS Standards.

44.10 **Working at Heights**

All working platforms, ways and other places of construction work shall be free from accumulations of debris or any other material causing obstructions and tripping.

Wherever workers are exposed to the hazard of falling in to water, the contractor shall provide adequate equipment for saving the employees from drowning and rescuing from such hazards. The contractor shall provide boat or launch equipped with sufficient number of life buoys, life jackets etc. manned with trained personnel at the site of such work.

Every opening at elevation from ground level through which a building worker, vehicle, material equipment etc. may fall at a construction work shall be covered and/or guarded suitably by the contractor to prevent such falls.

Wherever the workers are exposed to the hazards of falling from height, the contractor shall provide full harness safety belts fitted with fall arresting systems to all the employees working at higher elevations and life line of 8mm diameter wire rope with turn buckles for anchoring the safety belts while working or moving at higher elevations. Safety nets shall also be provided for saving them from fall from heights and such equipment should be in accordance with BIS standards.

Wherever there is a possibility of falling of any material, equipment or construction workers while working at heights, a suitable and adequate safety net should be provided. The safety net should be in accordance with BIS Standards.

The contractor shall provide standard prefabricated ladders on the columns where the workers are required to use them as an access for higher elevations till permanent staircase is provided. The workers shall be provided with safety belts fitted with suitable fall arresting system (fall arrestors) for climbing/getting down through ladder stop revent fall from height.

44.11 **Handling of Hazardous Chemicals and Explosives:**

The Contractor will notify well in advance to the Engineer I/C of his intention to bring to the Site any container filled with liquid or gaseous fuel or explosive or petroleum substance or such chemicals which may involve hazards. OWNER shall have the right to prescribe the conditions, under which such container is to be stored, handled and used during the performance of the works and the Contract shall strictly adhere to and comply with such instructions. The Engineer I/C shall have the right at his sole discretion to inspect any such container or such construction plant/equipment for which material in the container is required to be used and if in his opinion, its use is not safe, he may forbid its use. No claim due to such prohibition shall be entertained by OWNER and OWNER shall not entertain any claim of the Contractor towards additional safety provisions/conditions to be provided for /constructed.

Further, any such decision of the Engineer I/C shall not, in any way, absolve the Contractor of his responsibilities and in case, use of such a container or entry thereof into the Site area is forbidden by OWNER, the Contractor shall use alternative methods with the approval of the OWNER without any cost implication to the OWNER or extension of work schedule.

Where it is necessary to provide and/or store petroleum products or petroleum mixtures and explosives, the Contractor shall be responsible for carrying-out such provision and/ or storage in accordance with the rules and regulations laid down in Petroleum Act 1934, Explosives Act 1948, and Petroleum and Carbide of Calcium Manual published by the Chief Inspector of Explosives of India. All such storage shall have prior approval of the Engineer I/C. In case any approvals are necessary from the Chief Inspector (Explosives) or any statutory authorities, the Contractor shall be responsible for obtaining the same.

The Contractor shall be fully responsible for the safe storage of his and his Sub- contractor's radio-active sources in accordance with BARC/DAE (Bhabha Atomic Research Centre/ Department of Atomic Energy, Govt. of India) Rules and other applicable provisions. All precautionary measures stipulated by BARC/DAE in connection with use, the contractor would take storage and handling of such material.

The contractor shall provide suitable personal protective equipment to the workers who are handling the hazardous and corrosive substances including alkalis and acids.

As a precautionary measure the contractor should keep the bottles filled with distilled water in cupboard/Boxes near workplace for emergency eye wash by workers exposed to such hazardous chemicals.

44.12 **Eye Protection**

The contractor shall provide suitable personal protective equipment to his workmen depending upon the nature of hazards and ensure their usage by the workers engaged in operations like welding, cutting, chipping, grinding or similar operations which may cause injuries to his eyes.

44.13 **Excavation**

The contractor shall take all necessary measures during excavation to prevent the hazards of falling or sliding material or article from any bank or side of such excavation which is more than one and a half meter above his footing by providing adequate piling, shoring, bracing etc. against such bank or sides.

Adequate and suitable warning signs shall be put up at conspicuous places at the excavation work to prevent any persons or vehicles falling into the excavation trench. No worker should be allowed to work where he may be stuck or endangered by excavation machinery or collapse of excavations or trenches.

44.14 **Electrical Hazards**

The contractor should ensure that all electrical installations at the construction work comply with the requirements of latest electricity acts/rules.

The contractor shall take all adequate measures to prevent any worker from coming into physical contact with any electrical equipment or apparatus, machines or live electrical circuits which may cause electrical hazards during the construction work. The contractor shall provide the sufficient ELCBs /RCCBs for all the portable equipment, electrical switchboards, distribution panels etc. to prevent electrical shocks.

The contractor should ensure use of single / double insulated hand tools or low voltage i.e., 110 volts hand tools.

The contractor should also ensure that all temporary electrical installations at the construction works are provided with earth leakage circuit breakers.

44.15 **Vehicular Traffic**

The contractor should employ vehicle drivers who hold a valid driving license under the Motor Vehicles Act, 1988.

44.16 **Lifting Appliances, Tools & Tackles, Lifting Gear and Pressure Plant & Equipment etc.**

The contractor shall ensure all the lifting appliances, tools & tackles including cranes etc., lifting gear including fixed or movable and any plant or gear, hoists, Pressure Plant and equipment etc. are in good condition and shall be examined by competent person and only certified shall be used at sites. Periodical Examination and the tests for all lifting/hoisting equipment & tackles shall be carried out. A register of such examinations and tests shall beProperly maintained by the Contractor and will be promptly produced as and when desired by the Engineer-I/C or by the person authorized by him.

44.17 **Excessive Noise, Vibration**

The contractor shall take adequate measures to protect the workers against the harmful effect of excessive noise or vibration. The noise should not exceed the limits prescribed under the concerned rules, Noise Pollution (Regulation and Control) Rules, 2000.

44.18 **Electrical Installations**

The Contractor shall not interfere or disturb electric fuses, wiring and other electrical equipment belonging to the OWNER or other contractors under any circumstances, whatsoever, unless expressly permitted in writing by the Engineer-I/C to handle such fuses, wiring or electrical equipment.

Before the Contractor connects any electrical appliances to any plug or socket belonging to the other contractor or the OWNER, he shall

i. Satisfy the Engineer-I/C that the appliance is in good working condition;

ii. Inform the Engineer-I/C of the maximum current rating, voltage and phases of the appliances;

iii. Obtain permission of the Engineer-I/C detailing the sockets to which the appliances maybe connected.

The Engineer-I/C will not grant permission to connect until he is satisfied that:

a. The appliance is in good condition and is fitted with suitable plug; having earth connection with the body.

b. Wherever armoured/metallic sheathed multicore cable is used, the same armoured sheathed should be connected to earth.

iv. No repair work shall be carried out on any live equipment. The Engineer-I/C must declare the equipment safe and a permit to work shall be issued by the OWNER/contractor as the case may be to carry out any repair /maintenance work. While working on electric lines / equipment whether live or dead, suitable type and sufficient quantity of tools will have to be provided by the contractor to electricians/workmen/ Officers.

v. The contractor shall employ necessary number of qualified, full time Electricians/ Electrical Supervisors to maintain his temporary electrical installation.

The installations are provided with suitable ELCBs and RCCBs wherever required.

44.19 **Safety Organization**

44.19.1 The contractor employing more than 250 workmen whether temporary, casual, probationary, regular or permanent shall employ at least one full time safety officer exclusively to supervise safety aspects of the equipment and workmen, who will coordinate with the OWNER Safety Officer. Further requirement of safety officers, if any, shall be guided by Rule 209 of The Building and Other Construction Worker (Regulation of Employment and Conditions of Service) Central Rule 1998. In case the work is being carried out through subcontractor, the employees / workmen of the sub-contractor shall also be considered as the contractor's employees/workmen for the above purpose.

In case of contractor deploying less than 250 workmen he should designate one of his Engineer/supervisor or the contractor himself (if he is directly supervising the work) as safety officer in addition to his existing responsibilities. The Engineer/supervisor should get at least 2 days safety training from any reputed organization or from OWNER before resuming the work. If already trained in past the declaration along with training Certificate to be furnished to OWNER safety officer.

44.19.2 The name and address of such Safety Officer of the Contractor will be promptly informed in writing to the EIC with a copy to the Project Safety Officer before he starts work or immediately after any change of the incumbent is made during currency of the Contract.

44.20 **Reporting of Accident and Investigation**

In case any accident occurs during the construction/erection or other associated activities undertaken by the Contractor thereby causing any near miss, minor or major or fatal injury to his employees due to any reason, whatsoever, it shall be the responsibility of the Contractor to promptly inform the same to the Engineer I/C, OWNER Safety Officer with a copy to OWNER Head of Project in the prescribed form and also to all the authorities envisaged under the applicable laws.

44.21 **Right to stop Work**

44.21.1 The Engineer I/C shall have the right at his sole discretion to stop the work, if in his opinion the work is being carried out in such a way that it may cause

accidents and endanger the safety of the persons and / or property, and / or equipment. In such cases, the contractor shall be informed in writing about the nature of hazards and possible injury / accident and he shall comply to remove shortcomings promptly. The Contractor after stopping the specific work can, if felt necessary appeal against the order of stoppage of work to the Project Manager within 3 days of such stoppage of work and decision of the Project Manager in this respect shall be conclusive and binding on the Contractor.

4.21.2 The Contractor shall not be entitled for any damages / compensation for stoppage of work, due to safety reasons and the period of such stoppage of work shall not be taken as an extension of time for Completion of the Contract and will not be the ground for waiver of levy of liquidated damages.

44.22 **Fire Protection**

The contractor shall provide sufficient fire extinguishers at place/s of work. The fire extinguishers shall be properly maintained as per relevant BIS Standards. The employees shall be trained to operate the fire extinguishers /equipment.

44.23 **Penalties**

a) If the Contractor fails in providing safe working environment as per the Safety Rules of OWNER or continues the work even after being instructed to stop the work by the Engineer-in-charge, the Contractor shall be penalized at the rate of Rs. 25,000/- per day or part thereof till the instructions are complied with and so certified by the Engineer I/C. However, in case of accident, the provisions contained below shall also apply in addition to the penalties mentioned in this sub-clause.

b) If the Contractor does not take all safety precautions and/or fails to comply with the Safety Rules as prescribed by the OWNER or under the applicable law for the safety of the plant and equipment and for the safety of personnel and the contractor does not prevent hazardous conditions which cause injury to his own employees or employees of other contractors, or OWNER's employees or any other person who are at the Site or adjacent thereto, the Contractor shall be responsible for payment of penalty as per the following schedule:-

i. Fatal injury or accident causing death: Penalty @ 10% of contract value or Rs. 500,000/- per person, whichever is less.

ii. Major injuries or accident causing 25% or more permanent disablement to workmen or employees: Penalty @2.5% of contract value or Rs. 100,000/- per person whichever is less

Permanent disablement shall have the same meaning as indicated in 'The Workmen's Compensation Act'1923.

The penalty mentioned above shall be in addition to the compensation payable to the workmen/employees under the relevant provisions of the 'The Workmen's Compensation Act 1923' and rules framed there under or any other applicable laws as applicable from time to time.

c) If any contractor worker found working without using the safety equipment like safety helmet, safety shoes, safety belts, etc. or

without anchoring the safety belts while working at height the Engineer I/C/Safety Officer of OWNER shall have the right to penalize the contractor for Rs. 200/- per person per day and such worker shall be sent out of the work place immediately and shall not be allowed to work on that day. Engineer I/C / Safety Officer of OWNER will also issue a notice in this regard to the contractor.

d) If two or more fatal accidents occur at same OWNER site under the control of contract or during the period of contract and he has

i. Not complied with keeping adequate PPEs in stock or

ii. Defaulted in providing PPEs to his workmen

iii. Not followed statutory requirements / OWNER safety rules

iv. been issued warning notice/s by OWNER head of the project on non observance of safety norms

v. Not provided safety training to all his workmen, the contractor can be debarred from getting tender documents in OWNER for two years from the date of last accident.

e) The safety performance will also be one of the overriding criteria for evaluation of overall performance of the contractors by OWNER. The contractor shall submit the accident data including fatal / non-fatal accidents for the last 3years where he has undertaken the construction activities Projects-wise along with the tender documents. This will also be considered for evolution of tender documents. If the information given by the contractor found incorrect, his contract will be liable to be terminated.

44.24 A. The Contractor will make available minimum quantity of all safety equipment and safety PPEs of required specifications as per suggestive list included bidding documents as a part of "List of minimum T & P". Further Contractor will ensure availability of additional requirement for individual worker and safety equipment as per site requirement during execution of the contract till its completion.

B. The Contractor shall abide by the following during Construction and Erection activities:

I. Chain pulley block shall not be used for loads more than two (2) tonne.

II. Hydra shall not be used for material transport.

III. Cage shall necessarily be provided to Monkey ladders of height more than 4 m.

IV. Fencing shall be provided to all Electrical Distribution boards and transformers etc.

C. Contractor shall ensure implementation of Safety provisions.

45.0 **FOREIGN PERSONNEL**

45.1 The Contractor shall submit to the OWNER data on all personnel he proposes to bring into India from abroad for the performance of the Works under the Contract, at least sixty (60) days prior to their departure to India. Such data will include for each person the name, his present address, his assignment and responsibility in connection with the works, and a short resume of his qualification, experience etc. in relation to the work to be performed by him.

45.2 Any person unsuitable and unacceptable to the OWNER shall not be brought to India. Any person brought to India, if found unsuitable or unacceptable by the OWNER, the Contractor shall within a reasonable time make alternate arrangements for providing a suitable replacement and repatriation of such unsuitable personnel.

45.3 No person brought to India for the purposes of the works shall be repatriated without the consent of the OWNER in writing, based on a written request from the Contractor for such repatriation giving reasons for such an action to the OWNER. The OWNER may give permission for such repatriation provided he is satisfied that the progress of work will not suffer due to such repatriation.

45.4 The cost of passports, visas and all other travel expenses to and from India, incurred by the Contractor shall be to his account. The OWNER will not provide any residential accommodation and/or furniture for any of the Contractor's personnel including foreign personnel and Contractor shall make his own arrangements for such facilities.

45.5 The Contractor and his expatriate personnel shall respect all Indian Acts, Laws, rules and regulations and shall not in any way interfere with Indian political and religious affairs and shall conform to any other rules and regulations which the Government of India and the OWNER may establish from time to time, on them. The Contractor's expatriate personnel shall work and live in close co-operation and coordination with their co-workers and the community and shall not engage themselves in any other employment neither part-time nor full-time nor shall they take part in any local politics.

45.6 The OWNER shall assist the Contractor, to the extent possible, in obtaining necessary permits to travel to India and back, by issue of necessary certificates and other information needed by the Government agencies.

45.7 The Contractor shall pay all taxes due in India for the personnel employed by the Contractor for work arising out of the services of the foreign personnel in connection with the contract and obtaining at his (Contractor's) own cost 'Work Permits' from competent authorities to enable foreign personnel to work in India.

The Contractor shall be responsible for all formalities in connection with passports, obtaining of visas, policy permits and expenses for customs duties related to personal goods of foreign personnel to be employed in the erection work. However, the Owner shall, if requested, assist the Contractor in obtaining visas and 'work permits' for the foreign personnel to be deputed for the erection work

It shall be the core responsibility of the Contractor to engage any foreign personnel only on Employment Visa basis and not on Visitor Visa or Business

Visa as per circulars, notifications and guidelines issued by Ministry of External Affairs, Govt. of India and / or any Statute, Acts, Rules & regulations, provisions issued by Govt. of India in respect of issue of Visa for Foreign Personnel coming to India for the projects.

46.0 **FOUNDATION DRESSING & GROUTING FOR EQUIPMENT/ EQUIPMENT BASES**

46.1 The surfaces of foundations shall be dressed to bring the top surface of the foundations to the required level, prior to placement of equipment/equipment basis on the foundations.

46.2 All the equipment/equipment bases, shall be grouted and finished as per these specifications unless otherwise recommended by the equipment manufacturer.

46.3 The concrete foundation surfaces shall be properly prepared by chipping, grinding as required to bring the top of such foundation to the required level, to provide the necessary roughness for bondage and to assure enough bearing strength.

46.4 **Grout**

46.4.1 The grout shall be high strength grout having a minimum characteristic compressive strength of 60 N/mm^{2}at 28 days from being cast. The grout shall be chloride free, cement based, free flowing, non-metallic grout.

46.4.2 The grout shall have good flow ability even at very low water/grout powder ratio.

46.4.3 The grout shall have characteristics of controlled expansion to be able to occupy its original volume to fill the voids and to compensate for shrinkage. Grout shall be of pre-mix variety so that only water needs to be added before use.

46.4.4 The mixing of the Grout shall conform to the recommendations of the manufacturer of the Grout.

46.5 **Placing of Grout**

46.5.1 After the base has been prepared, its alignment and level has been checked and approved and before actually placing the grout, a low dam shall be set around the base at a distance that will permit pouring and manipulation of the grout. The height of such dam shall be at least 25 mm above the bottom of the base. Suitable size and number of chains shall be introduced under the base before placing the grout, so that such chains can be moved back & forth to push the grout into every part of the space under the base.

46.5.2 The grout shall be poured either through grout holes if provided or shall be poured at one side or at two adjacent sides to make the grout move in a solid mass under the base and out in the opposite side. Pouring shall be continued until the entire space below the base is thoroughly filled and the grout stands at least 25mm higher all around than the bottom of the base. Enough care should be taken to avoid any air or water pockets beneath the bases.

46.5.3 In addition to the above, recommendations of Grout manufacturer shall also be followed.

46.6 **Finishing of the Edges of the Grout**

46.6.1 The poured grout should be allowed to stand undisturbed until it is well set. Immediately thereafter, the dam shall be removed and grout which extends beyond the edges of the structural or equipment base plates shall be cut off, flushed and removed. The edges of the grout shall then be pointed and finished with 1:2 cement mortar pressed firmly to bond with the body of the grout and smoothened with a tool to present a smooth vertical surface. The work shall be done in a clean and scientific manner and the adjacent floor spaces, exposed edges of the foundations ,and structural steel and equipment base plates shall be thoroughly cleaned of any spillage of the grout.

46.7 **Checking of Equipment after Grouting**

46.7.1 After the grout is set and cured, the Contractor shall check and verify the alignment of equipment, alignment of shafts of rotating machinery, the slopes of all bearing pedestals, centering of rotors with respect to their sealing bores, couplings, etc. as applicable and the like items to ensure that no displacement had taken placed during grouting. The values recorded prior to grouting shall be used during such post grouting check-up and verifications. Such pre and post grout records of alignment details shall be maintained by the Contractor in a manner acceptable to the Owner.

47.0 **SHAFT ALIGNMENTS**

All the shafts of rotating equipment shall be properly aligned to those of the matching equipment to as perfecta accuracy as practicable. The equipment shall be free from excessive vibrations so as to avoid overheating of bearings or other conditions which may tend to shorten the life of the equipment. The vibration level of rotating equipment measured at bearing housing shall conform to Zone A of ISO 10816. All bearings, shafts and other rotating parts shall be thoroughly cleaned and suitably lubricated before starting.

48.0 **DOWELLING**

All the motors and other equipment shall be suitably dowelled after alignment of shafts with tapered machined dowels as per the direction of the Owner.

49.0 **CHECK OUT OF CONTROL SYSTEMS**

After completion of wiring, cabling furnished under separate specification and laid and terminated by the OWNER, the Contractor shall checkout the operation of all control systems for the equipment furnished and installed under these specifications and documents.

50.0

50.1 It will be the responsibility of the Contractor to provide all commissioning spares including consumable spares required for initial operation till the Final Taking Over. The Contractor shall furnish a list of all commissioning spares within 60 days from the date of Notification of Award and such list shall be reviewed by the Owner and mutually agreed to. However, such review and agreement will not absolve the Contractor of his responsibilities to supply all commissioning spares so that initial operation do not suffer for want of commissioning spares. All commissioning spares shall be deemed to be included in the scope of the Contract at no extra cost to the Owner.

50.2 These spare will be received and stored by the Contractor at least three (3) months prior to the schedule date of commencement of initial operation of the respective equipment and utilized as and when required. The unutilized spares and replaced parts, if any, at the end of successful completion of guarantee tests shall be the property of the Contractor and he will be allowed to take these parts back at his own cost with the permission of Owner.

51.0 **CABLING**

51.1 All Cables shall be supported by conduits or cable tray run in air or in cable channels. These shall be installed and exposed runs parallel or perpendicular to dominant surfaces with right angle turn made of symmetrical bends or fittings. When cables are run on cable trays, they shall be clamped at minimum intervals of 2000 mm or otherwise as directed by the Owner.

51.2 Each cable, whether power or control, shall be provided with a metallic or plastic tag of an approved type, bearing a cable reference number indicated in the cable and conduit list (prepared by the Contractor), at every 5 meter run or part thereof and at both end sof the cable adjacent to the terminations. Cable routing is to be done in such a way that cables are accessible for any maintenance and for easy identification.

51.3 Sharp bending and kinking of cables shall be avoided. The minimum radii for PVC insulted cables 1100 V grade shall be 15D (where D is the overall diameter of the cable). Installation of other cables like high voltage, coaxial, screened, compensating, mineral insulated shall be in accordance with the cable manufacturer's recommendations. Wherever cables cross roads and water, oil, sewage or gas lines, special care should be taken for the protection of the cables in designing the cable channels.

51.4 In each cable run some extra length shall be kept at a suitable point to enable one or two straight through joints to be made, should the cable develop fault at a later date.

51.5 Control cable terminations shall be made in accordance with wiring diagrams, using identifying codes subject to the Owner's approval. Multicore control cable jackets shall be removed as required to train and terminate the conductors. The cable jacket shall be left on the cable, as far as possible, to the point of the first conductor branch. The insulated conductors from which the jacket is removed shall be neatly twined in bundles and terminated. The bundles shall be firmly but not tightly tied utilizing plastic or nylon ties or specifically treated fungus protected cord made for this purpose. Control cable conductor insulation shall be securely and evenly cut.

51.6 The connectors for control cables shall be covered with a transparent insulating sleeve so as to prevent accidental contact with ground or adjacent terminals and shall preferably terminate in Elmex terminals and washers. The insulating sleeve shall be fire resistant and shall be long enough to over pass the conductor insulation. All control cables shall be fanned out and connection made to terminal blocks and test equipment for proper operation before cables are corded together.

52.0 EQUIPMENT DELIVERY AND ERECTION

52.1 General Requirements

a) This part covers Contractor's responsibilities for packing, shipping, ware housing and the installation of all equipment and materials furnished and installed under this specification.

b) The Contractor shall submit for Owner's approval draft manual for Equipment Delivery and Erection (EDE Manual) covering detailed instructions, write-up, technical data, drawings, checklists, documentation formats for all activities after equipment manufacture up to installation of equipment. This manual shall cover general instructions for all equipment and specific instructions for individual equipment wherever required and shall include at least the following:

1. Instructions for packing, shipping, receiving handling, ware-housing and storage.

2. Instructions for location and installation of equipment furnished by this specification.

3. Installation drawings for field mounted equipment, panels, cubicles and other equipment covered under this specification.

4. Instruction relating installation of piping/tubing, support and routing drawings of impulse pipes / signal tubes and tube/cable trays.

5. Check lists and quality assurance hold point.

6. Format for all related documentation.

c) The EDE Manual shall conform to the requirements of this specification, all applicable codes and standards, recommendations of equipment manufacturers and accepted good engineering practices and shall be subject to Owner approval during detailed engineering.

d) The Contractor shall ensure that all work under this part shall be performed as per the requirements of this specification. Owner approved EDE Manual and drawing / documents approved by the Owner during detailed engineering.

52.2 Crating

a. All equipment and materials shall be suitably coated, wrapped, or covered and boxed or crated for moist humid tropical shipment and to prevent damage or deterioration during handling and storage at the site.

b. Equipment shall be packed with suitable desiccants, sealed in waterproof vapor-proof wrapping and packed in lumber of plywood enclosures, suitably braced, tied and skidded. Lumber enclosures shall be solid, not slatted.

c. Desiccants shall be either silica gel or calcium sulphate, sufficiently ground to provide the required surface area and activated prior to placing in the packaging. Calcium sulphate desiccants shall be of a chemical nature to absorb moisture. In any case, the desiccant shall not be of a type that will absorb enough moisture to go into solution. Desiccants shall be packed in porous containers, strong enough to with stand handling encountered during normal shipment. Enough desiccant shall be used for the volumes enclosed in wrapping.

d. Review by the Owner of the Contractor's proposed packaging methods shall not relieve the Contractor of responsibility for damage or deterioration to the equipment and materials specified.

e. All accessory items shall be shipped with the equipment. Boxes and crates containing accessory items shall be marked so that they are identified with the main equipment. The contents of each box and crates shall be indicated by markings on the exterior.

f. All boxes, crates, cases bundles, loose pieces, etc. shall be marked consecutively from No.1 upward throughout all shipments from a given port to completion of the order without repeating the same number.

g. An itemized list of contents shall be enclosed inside each case and one other copy securely fastened to the outside of the case in a tin or lightweight sheet metal envelope or pocket. The lists shall be plainly marked and placed in accessible locations to facilitate receipt and inspection. The packing list shall indicate whether shipment is partial or complete and shall incorporate the following information on each container, etc. according to its individual shipping number:

1. Export case markings
2. Case number
3. Gross weight and net weight in Kilograms
4. Dimensions in centimeters
5. Complete description of material

h. Packaging or shipping units shall be designed within the limitations of unloading facilities and the equipment which will be used for transport. Complications involved with ocean shipment and the limitations of ports, railways and roads shall be considered. It shall be the Contractor's responsibility to investigate these limitations and to provide suitable packaging to permit safe handling during transit and at the job site.

i. Electrical equipment, control and instrumentation shall be protected against moisture and water damage. All external gasket surfaces and flange faces, couplings, motor pump shafts, bearing and like items shall be thoroughly cleaned and coated with rust preventive compound as specified above and protected with suitable wood, metal or other substantial type covering to ensure their full protection.

j. Equipment having antifriction or sleeve bearings shall be protected by weather tight enclosures.

k. Coated surfaces shall be protected against impact, abrasion, discoloration and other damage. Surfaces which are damaged shall be repaired.

l. All exposed threaded parts shall be greased and protected with metallic or other substantial type protectors. All female threaded openings shall be closed with forged steel plugs. All piping, tubing and conduit equipment and other equipment openings shall be sealed with metallic or other rough usage covers and tapped to seal the interior of the equipment piping, tubing, or conduit.

m. Provisions shall be made to ensure that water does not enter any equipment during shipment or in storage at the plant site.

n. Returnable containers and special shipping devices shall be returned by the manufacturer's field representative at the Contractor's expense.

o. While packaging the material, care shall be taken for the limitation from the point of view of availability of railway wagon sizes in India.

52.3 **Factory Assembly**

a. Instrument enclosures shall be supplied and erected completely in the factory with instrument, air supply and blow down piping with necessary valves, fittings, etc. and also all electrical wiring between the instruments and the enclosure terminal blocks. Control panel and cubicles shall also be fully wired in the factory. Control panel mounted equipment are to be dis mounted from the panels before shipment and individually packed for shipment. Electronic control modules of the plug-in type are to be removed from equipment racks after factory check out are individually packed for shipment. Other equipment shall be fully assembled at the factory, except for necessary shipping splits in panels.

b. All separately packaged accessories items and part shall be shipped with the equipment. Containers for separately packaged items shall be marked so that they are identified with the main equipment. An itemized packing slip, indicating what is in that carton only, shall be attached to the outside and inside of each container used for packing.

c. A master packing slip covering all accessories items for a given piece of equipment which are shipped in separate containers, shall be attached to one container.

52.4 **Equipment Installation**

i. **General Requirements**

1. The Contractor shall furnish all construction materials, tools and equipment and shall perform all work required for complete installation of all control and instrument equipment furnished under this specification.

2. Contractor shall prepare detailed installation drawings for each equipment furnished under this specification for Owner's approval. Installation of all equipment/ systems furnished by this specification shall be as per Owner's approval.

3. Erection procedures not specified herein shall be in accordance with the recommendations of the equipment manufacturers. The procedures shall be acceptable to the Owner.

4. The Contractor shall coordinate his work with other suppliers where their instruments and devices are to be installed under specifications.

ii. **Installation Materials**

All materials required for installation, testing and commissioning of the equipment shall be furnished by the Contractor.

iii. **Regulator Requirements**

All installation procedures shall confirm with the accepted good engineering practice and with all applicable government laws, regulations and codes.

iv. **Cleaning**

All equipment shall be cleaned of all sand, dirt and other foreign materials immediately after removal from storage and before the equipment is brought inside the power plant building or to other installation sites. All piping and tubes shall be air blown.

v. **Equipment Assembly**

Equipment installed under these specifications shall be assembled if shipped unassembled. The equipment shall be dismantled and reassembled as required to perform the installation and commissioning work described in these specifications.

vi. **Equipment Setting**

Field mounted instruments and accessories shall be bracket or sub panel mounted on the nearest suitable firm steel work or masonry. The brackets, stands, supports and other miscellaneous hard ware required for mounting instruments and accessories such as receiver gauge, air set, valve manifold, purge-meter etc. shall be furnished and installed. No field mounted instruments shall be installed such that it depends for support or rigidity on the impulse piping or on electrical connection to it.

Indicating type field mounted instruments shall be installed in such away that center of indicating dial shall be about 1600-1800 mm from operating floor level. Non-indicating type field instruments shall be installed such that operating handle of manifold block/isolating cock comes within 1600mm from operating floor level.

All free standing instrumentation cabinets and panels shall be located within the construction tolerances of +/-3 mm of the location dimensions indicated on the Owner's plant arrangement drawings.

vii. **Free Standing Equipment**

Free-standing Cabinets shall be attached to the floor, concrete equipment bases or supporting steel as indicated on the manufacturer's drawings and the Owner's Plant Arrangement Drawings. The cabinets shall be shimmed for proper alignment before bolting them to the floor. Adjacent enclosures shall be shimmed to maintain mutually level appearance before they are attached to floor. Vibration dampening mounts shall be installed between supporting structures and panels when specified.

viii. **Non-free Standing Equipment**

1. Non-freestanding local enclosures and cabinets shall be mounted in accessible locations on columns, walls, or stands in locations as indicated on the Owner's Plant Arrangement Drawings. Bracket and stands shall be fabricated as required to install the local enclosures and cabinets in a workman like manner.

2. Rough edges and welds on all fabricated supports shall be ground smooth. The supports shall be finished with two coats of primer and two coats of paint as specified in this part.

ix. **Equipment Location**

1. All individual items of equipment not located in cabinets or on panels and racks are located approximately according to the floor elevation and the nearest building column designated by the Owner.

2. Solenoid valves not located in enclosures or mounted on valves shall be mounted in easily accessible protected locations near the components with which they are associated.

3. All brackets, stands, supports and other miscellaneous hardware required for mounting devices shall be furnished and installed.

4. Thermometers shall be installed in the process lines and ducts as required and adjusted for ease in reading.

5. Permanent temperature wells on the main steam, hot reheat and cold reheat piping shall not be installed until steam blowing has been completed. Temporary temperature wells shall be installed in the main and reheat steam piping during steam blow and discarded after completion.

6. Any required adapting hard ware such as pipe bushings, nipples, drilled caps and the like shall be provided for complete installation of control devices into process connections.

7. For location of C&I related equipment/devices, the requirement specified elsewhere in the technical specification may be referred.

x. **Installation of Field Mounted Instruments and devices**

The Contractor shall submit installation drawings for all field mounted equipment furnished under this specification for Owner's approval. These drawings shall meet the requirements of this specification, installation drawings, applicable codes and standards and recommendations of

manufacturers of instruments/devices. All installation work under this specification shall be strictly as per installation drawings approved by the Owner during detailed engineering stage.

In addition to above relevant Portion as specified elsewhere in technical specification may be referred.

xi. **Piping Connections**

1. All equipment having piping connections shall be leveled, aligned and wedged in place but shall not be grouted or bolted prior to the initial fitting and alignment of connecting piping. All equipment shall, however, be grouted or bolted to its foundation prior to final bolting or welding of the connection piping.

2. All flanged joints shall be checked and retightened after approximately 10 days of operation at normal operating temperature.

xii. **Equipment Checkout**

1. All equipment shall be cleaned after installation. Equipment subject to pressure differentials shall be checked for leakage.

2. After erection, all equipment having moving parts, having electrical apparatus, or subject to pressure differentials shall be trial-operated.

xiii. **Defects**

1. All defects in erection shall be corrected to the satisfaction of the Owner and the Project Manager. The dismantling and reassembly of Contractor furnished equipment to remove defective parts, replace parts, or make adjustments shall be included as a part of the work under these specifications.

2. The removal of control and instrument equipment in order to allow bench calibration, if required, and the re-installation of the said equipment after calibration shall also be included as apart of the work under these specifications.

xiv. **Equipment Protection**

1. All equipment to be erected under these specifications shall be protected from damage of any kind from the time of contract award until commissioning of the unit.

2. The equipment shall be protected during storage as described herein.

3. Equipment shall be protected from weld spatter during construction.

4. Suitable guards shall be provided for protection of personnel on all exposed rotating or moving machine parts. All such guards with necessary spares and accessories shall be designed for easy removal and maintenance.

5. Equipment has glass components such as gauges, or equipment having other easily breakable components, shall be protected during the construction period with plywood enclosures or other suitable means. Broken, stolen, or lost components shall be replaced by the Contractor.

6. Machine finished surfaces, polished surfaces or other bare metal surfaces which are not to be painted, such as machinery shafts and couplings shall be provided temporary protection during storage and constructional periods by a coating of a suitable non-drying, oily type, rust preventive compound.

53.0 WELDING-SPECIAL REQUIREMENTS

If the manufacturer has special requirements relating to the welding procedures for welds at the terminals of the equipment to be performed under separate specifications, the requirements shall be submitted to the Project Manager in advance of commencement of erection work.

54.0 DEVIATIONS DISPOSITIONING

Any deviation to the contract and OWNER approved documents shall be properly recorded in the format prescribed by OWNER. All the deviations shall be bought to the knowledge of OWNER's representative for suitable dispositioning.

55.0 NON-DESTRUCTIVE TESTING (NDT)

The contractor shall record results of NDTs carried out at site in the format acceptable to OWNER. All the radiographs & its report duly signed & correlated to the job shall be handed over to the OWNER. Sensitivity of all the test equipment shall be compatible to the job & acceptance norms agreed.

56.0 TESTING EQUIPMENT & FACILITIES

Contractor shall provide the testing equipment and facilities necessary to carry out tests & inspections.

57.0 DEFECTIVE WORKS

If the work or any portion thereof be damaged in any way excepting by the acts of the Owner, or if defects not readily detected by prior inspection be developed before the final completion and acceptance of the whole work, the Contractor shall forthwith make good, without compensation, such damage or defects in a manner satisfactory to the Owner/Engineer. In no case shall defective or imperfect work be retained.

58.0 PROGRESSIVE PAYMENT FOR SITE WORK

All progressive payments for construction and erection works shall be based on milestone progress achieved. The Contractor shall submit a detailed schedule for such milestones, which shall be mutually discussed and agreed between Owner and Contractor.

The Contractor shall not demand nor be entitled to receive payment for the work or portion thereof, except in the manner set-forth in the Contract Agreement and only after the Owner/Engineer certification for such payment.

59.0 ADHERENCE TO MANUFACTURER'S INSTRUCTION

Adherence to instructions of the manufacturer's supervisory engineers, where provided, is compulsory. The Contractor shall work under the guidance of the manufacturer's supervisors to ensure that erection procedure adopted by the Contractor as well as completed erection of equipment is such as not to interfere with or prevent equipment from functioning as intended, as well as to the entire satisfaction of the manufacturer's supervisor/Owner/Engineer. The Contractor shall also permit and provide all facilities for the manufacturer's erection supervisors to carry out all checks that they may wish to and approve any erection procedure and/or final setting and alignment of component, in order to satisfy themselves that erection has been carried out as intended by them. This shall, however, in no way relieve the Contractor of his responsibility for providing adequate and competent supervision and quality workmanship. In case of any dispute, the decision of the Owner/ Engineer/Manufacturer's erection supervisor shall be final.

60.0 MODIFICATIONS

The Contractor shall carry out all modifications at site as directed by the Owner/Engineer to complete the work covered in this contract. It is the responsibility of the Contractor to get the prior approval for such modifications from the Owner/Engineer before such works are taken final.

ANNEXURE-I

STANDARD CHECK LIST

COMMISSIONING/TESTING ESSENTIAL PRE-REQUISITE

MECHANICAL

A) VALVES

1) MANUALLY OPERATED VALVE
2) ELECTRICALLY OPERATED VALVE
3) PNEUMATICALLY ACTUATED VALVE
4) HYDRAULICALLY ACTUATED VALVE
5) SAFETY VALVE
6) ELECTROMATIC RELIEF VALVE
7) STEAM TRAP
8) BUTTER FLY VALVE (ELECTRICALLY OPERATED)
9) BUTTERFLY VALVE (MANUALLY OPERATED)
10) BUTTERFLY VALVE (FOURWAY-ELECTRICAL)
11) NON-RETURN VALVE (INCLUDING HYDRAULIC/PNEUMATIC)
12) THREE WAY CONTROL VALVE
13) RELIEF VALVE
14) DIFFERENTIAL PRESSURE REGULATING VALVE
15) FLOAT OPERATED VALVES

B) TANKS AND PRESSURE VESSELS

1) TANKS (METAL) UPTO $20M^2$
2) TANKS (LARGE STORAGE)
3) PRESSURE VESSEL (BELOW 17 BARS)
4) AIR RECEIVER
5) PRESSURE VESSEL – ACCESS DOOR
6) TURBINE MAIN OIL TANK

C) PUMPS

1) PUMP LOW PRESSURE CENTRIFUGAL (MOTOR DRIVEN)
2) PUMP UPTO 350HP (260KW)
3) PUMP SUMP INSTALLATION
4) GEAR PUMP/SCREW PUMP

D) PIPEWORKSYSTEM

1) STEAM SERVICES
2) WATER SERVICES
3) OIL/FIRE RESISTANT FLUID SYSTEM
4) AIR SERVICES (COMPRESSOR)
5) HIGH PRESSURE SERVICES

6) CONSTANT LOAD SUPPORT
7) SPRING SUPPORTS
8) HANGERS AND OTHER SUPPORTS

E) STRAINER AND FILTERS

1) STRAINER/FILTER BASKEK TYPE
2) STRAINER ROTARY (LOW PRESSURE)
3) FILTER & STRAINERS CENTRIFUGAL SEPARATORS
4) FILTER & STRAINER Y-TYPE
5) FILTER & STRAINER (PLATETYPE)
6) PURIFIER
7) FILTER-COMPRESSEDAIRLINE

F) HEAT EXCHANGERS

1) HEAT EXCHANGER (GENERAL)
2) HEAT EXCHANGER - OIL/WATER
3) ROTARY AIR HEATER

G) FANS AND COMPRESSORS

1) FANS-NON-PRESSURE LUBRICATED
2) FANS-AXIAL FLOW PRESSURE LUBRICATED
3) COMPRESSORS-GENERAL
4) DAMPERS & GATES

H) CRANES AND ELEVATORS

1) AUXILIARY OVER HEAD CRANE
2) TRAVEL SUPPORT STRUCTURE FOR CRANE
3) LONG TRAVEL & CROSS TRAVERSE MOTION OF CRANE
4) MAIN AUX.HOIST MOTION (CRANE)
5) ELECTRIC HOIST

I) POWER TRANMISSION

1) POWERTRANSMISSIONGEARBOX(2.)BEARING
2) BEARING
3) FLUIDCOUPLINGS

ELECTRICAL

1) D.C.MOTOR
2) HV SQUIRREL CAGE INDUCTION MOTOR
3) 415 V SQUIRREL CAGE INDUCTION MOTOR
4) MOTOR OPERATED ACTUATORS
5) LT SWITCHGEARS/MCC

i) STANDARD CHECK LISTS FOR ALL TYPES OF RELAYS USED IN SWITCH GEARS PROTECTION SYSTEM
ii) PT CARRIAGE AND CUBICLES
iii) CABLE/BUSDUCT/BUSBARS
iv) CONTRACTOR MODULE
v) SWITCH FUSE MODULE
vi) MASTER PANEL OF LUBE OIL PANEL
vii) FEEDER PANEL OF LUBE OIL PANEL
viii) SPACE HEATER AND CABLE MODULE
ix) CONTROL TRANSFORMER MODULE
x) HT CIRCUIT BREAKER
xi) 415V CIRCUIT BREAKER

6) POWER CABLE
7) CONTROL CABLE
8) AUXILIARY CABLE
9) D.C. CABLE
10 EXPLOSION PROOF ELECTRICAL EQUIPMENT
11) JUNCTION BOX
12) CONTROL TRANSFORMER MODULE
13) BRUSH GEAR ASSEMBLY
14) AUX.CONTROL AND RELAY PANEL DESK
15) INDICATING INSTRUMENT
16) RECORDING INSTRUMENT
17) INTEGRATING INSTRUMENT

3. CONTROL & INSTRUMENTATION

A) CONDUCTIVITY ANALYSING EQUIPMENT INCLUDINGT EST PROCEDURES
B) PH ANALYSER INCLUDING TEST PROCEDURE
C) SILICA ANALYSER
D) LEVEL SWITCH (FLOATACTUATED)
E) LEVEL SWITCH (ELECTRODETYPE)
F) LEVEL SWITCH (DISPLACERACTUATED)
G) TRANSMITTER (FLOAT OPERATED PNEUMATIC OUTPUT) INCLUDING TESTING PROCEDURE
H) LEVEL INDICATOR (FLOAT/PULLEYTYPE)
I) LOCAL TEMPERATURE INDICATORS INCLUDING TEST PROCEDURE
J) RESISTANCE THERMO METER ELEMENT INCLUDING TEST PROCEDURE
K) THERMO COUPLE ELEMENT AND CONNECTING CABLE
L) THERMO COUPLE AND RESISTANCE THERMOMETER CONVERTOR/TRANSMITTER INCLUDING TEST PROCEDURES.
M) TEMPERATURE SWITCH/THERMOSTAT INCLUDING TEST PROCEDURES
N) COLD JUNCTION BOXES
O) ZENER BARRIER
P) O_2 ANALYSER
Q) O_2 IN HYDROGEN INCLUDING TEST PROCEDURES

R) PRESSURE AND VACUUM GAUGE
S) PRESSURE AND VACUUM SWITCH INCLUDING TEST PROCEDURE
T) DIFFERENTIAL PRESSURE TRANSMITTER INCLUDING TEST PROCEDURE
U) DIFFERENTIAL PRESSURE SWITCH INCLUDING TEST PROCEDURE.
V) FLOW INDICATOR (VARIABLE AREA)
W) ORIFICE PLATE
X) TURBINE FLOW TRANSMITTER

i) FLOW SWITCH
ii) WEIR
iii) NOZZLE
iv) FLOW INDICATOR (PNEUMATIC INPUT) INCLUDING TEST PROCEDURE
v) FLOW INTEGRATOR (PNEUMATIC INPUT) INCLUDING TEST PROCEDURE
vi) FLOW INDICATOR (FLOATOPERATED) INCLUDING TEST PROCEDURE
vii) VENTURI (FLUID)
viii) FLOW SWITCH (MAGNETIC TYPE)
ix) AVERAGING INLET
x) LIMIT SWITCHES

Y) TURBINE SUPERVISORY MEASURING SYSTEM
Z) POSITION MEASUREMENT AND INDICATION INCLUDING TEST PROCEDURES
AA) TACHOMETER
BB VIBRATION MEASUREMENT
CC) DIGITAL INDICATOR
DD) MOVING COIL INDICATOR INCLUDINGTESTPROCEDURE
EE) RECORDER INCLUDING TEST PROCEDURE
FF) FLAME SCANNER
GG) ELECTRICA LAUTOMANUALCONTROL STATION
HH) PUSH BUTTON MODULE
II) ALARM ANNUNCIATOR EQUIPMENT INCLUDING TEST PRO
JJ) TEST PROCEDURE FOR ELECTRONIC MODULES OF DDCMIS
KK) THERMO CONTROL VALVE
LL) TEST PROCEDURE FOR ADJUSTMENT OF MODULATING CONTROLLER-PID TERMS
MM) TEST PROCEDURE INDICATING CONTROLLER - ELECTRICAL INPUT AND PNEUMATIC OUT PUT

ANNEXURE-II

BRIEF WRITE UP ON THE CONTENTS OF TESTING SCHEDULE/COMMISSIONING SCHEDULE

Testing Schedules should be designed to ensure that the plant area, equipment or apparatus are tested and commissioned and will operate as per the OWNER's specifications and good engineering practices.

Testing Schedule/Commissioning Schedule is required to be of a standard format in order to maintain consistency of presentation, content and reporting.

Testing Schedule/ Commissioning Schedule should contain the following sections to make the document a self-contained one:

1. Plant Details/Design data

2. Testing Objective/Proposals

3. State of the Plant

    a) Erection Status with respect to Mechanical, Electrical and C&I
    b) Availability of the services required
    c) Safety requirements as per Manufacturers

4. Test method including completion/acceptance criteria

5. Results

6. Appendix

    a) Testing Program
    b) Mech/Elect/C&I-Plant item completing list
    c) List of Drawing/documents required for carrying out the testing.

ANNEXURE – III

SAFETYPLAN

1. Safety Policy of the Contractor to be enclosed
2. When the Safety Policy was last reviewed.
3. Details of implementation procedure/methods to implement Safety Policy/Safety Rules
4. Name, Qualification, experience of Safety Officer
5. Review of Accidents Analysis Method, Methods to ensure Safety and Health
6. Unit executive responsible to ensure Safety at various levels in work area
7. List of employee strained in safety employed before execution of the job. Give the details of training
8. Safety Training Targets, Schedules, methods adopting to providing safety training to all employees
9. Details of check list for different jobs/work and responsible person to ensure compliance (copy of check list to be enclosed)
10. Regular Safety Inspection Methods and Periodicity and list of members to been closed
11. Risk Assessment, Safety Audit by Professional Agencies, Periodicity
12. Implementation of Recommendations of Audit/Inspections. Procedures for implementation and follow up
13. Provision for treatment of injured persons at work site
14. Review of overall safety by top Management and Periodicity
15. System for Implementation of Statutory legislations
16. Issue of PPEs to employees, Periodicity/stock on hand etc.,

Signature
Head of the Organization
with date & stamp

CHAPTER – 7

PAINTING

1.0 SCOPE

1.1 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

2.1 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.

2.2 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 Owner / 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 Owner 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 Owner:

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/m^2. Surfaces that do not meet these criteria shall be reprocessed.

4.4 **Mechanical Cleaning:**

4.4.1 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 Owner/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.

4.5 **Blast cleaning:**

4.5.1 **Compressors:** Compressed air supply for blast cleaning shall be free of water and oil. Air compressors shall not be allowed to deliver air at 110^0 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.

4.5.2 **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.).

4.5.3 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.

4.5.4 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.

4.5.5 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.

4.5.6 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.

4.5.7 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).

4.5.8 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.

4.5.9 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

4.6 **Paint Application**

4.6.1 **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 Owner / 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 Owner / Engineer not to be painted.

4.6.2 **Paint Application Requirements**

4.6.2.1 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.

4.6.2.2 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.

4.6.2.3 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 Owner 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.

4.6.2.4 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.

4.6.2.5 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.

4.6.2.6 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.

4.6.2.7 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.

4.6.2.8 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.

4.6.2.9 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).

4.6.2.10 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.

4.6.3 **Spray Application**

4.6.3.1 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.

4.6.3.2 Approval of Owner / 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:

4.6.3.3 The correct spray tips, air pressures, etc, as recommended by the equipment supplier, shall be used.

4.6.3.4 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.

4.6.3.5 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.

4.6.3.6 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.

4.6.3.7 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.

4.6.3.8 Very complex structures should be painted by brush instead of spray gun to avoid overspray, dry spray and unacceptable paint losses.

4.6.4 **Brush application**

4.6.4.1 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.

4.6.4.2 Brushes shall be of a style and quality that will permit the proper application of paint.

4.6.4.3 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.

4.6.4.4 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.

4.6.5 **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.

4.6.6 **Coating materials**

4.6.6.1 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.

4.6.6.2 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 dis bonding test (internal coating)
- Abrasion test (internal coating)
- Impact resistance test

4.6.6.3 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.

4.6.6.4 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.

4.6.7 **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 gm/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/m²	Thickness loss µm
C2	Low	>10 to 200	>1.30 to 25
C3	Medium	200-400 g/m^2	(25-50µm)
C4	High	400-650 g/m^2	(50-80µm)
C5	Very High Industrial & marine	650-1500g/m^2	(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

5.0 **INSPECTION:**

5.1 Inspection will be performed by an inspector authorised by Owner / 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.

5.2 The painting work shall be subjected to inspection by Owner / engineer at all times. The vendor shall offer following stage of inspection:

- Surface preparation
- Primer application
- Subsequent coats
- Paint qualification test

5.3 Vendor shall provide the expert technical services of the paint manufactures as and when required by Owner / 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 Owner.

5.4 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:**

S 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		

S No.	Item/Service	Colour	IS-5	Colour (Band)	IS-5
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 Yellow	356		
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

DFT of each coat shall be 40 microns.

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.	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
5.	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
6.	Fuel pipings	Sa 2	Ehthy Zn silicate	1	40 µ				HR aluminium paint	2	40 µ	80µ
7.	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
8.	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
9.	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
10.	Burried piping (Internal)	Sa 2 ½	Solid rigid poly eurethene 500 µ									500µ
11.	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
12.	Storage tanks (internal)	Sa 2 ½	3 coats of amine adducts									400µ
13.	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
14.	Fuel oil tanks (internal)	Sa 2 ½	In organic Zn	2	80	HB MIO	1	150	HB coal tar epoxy	1	150	380µ

			silicate		µ	epoxy		µ			µ	
15.	Insulated parts continuously exposed to condensing water	Sa 2 ½	In organic Zn silicate	2	75 µ							75µ
16.	For insulted piping <125^{0}C	Sa 2 ½	Polyamide cured epoxy coasting	2	25 0 µ							250µ
17.	Electrical parts, control panels, valves, pumps & motors (indoor)*	Sa 2 ½	Zn phosphate epoxy	2	80 µ				Chlorinated rubber	2	80 µ	160µ
18.	Electrical parts, control panels, valves, pumps & motors (outdoor)*	Sa 2 ½	Zn phosphate epoxy	2	80 µ				Chlorinated rubber	2	100 µ	180µ
19.	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.	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
5.	Coal Handling Plant	Sa 2 ½	HB Zn Phospate	2	80 µ	HB MIO epoxy	2	200 µ	Poly eurethene	2	60 µ	340µ
6.	Coal Fuel piping	Sa 2	Ehthy Zn silicate	1	40 µ				HR aluminium paint	2	40 µ	80µ
7.	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
8.	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
9.	Buried piping (external)	Sa 2 ½	Coal tar primer, coal tar enamel, inner wrap of fibre glass, final outer wrap of enamel									4.0 mm
10.	Buried piping (internal)	Sa 2 ½	Solid rigid poly eurethene 500 µ									500µ
11.	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
12.	Storage tanks (internal)	Sa 2 ½	3 coats of amine adducts									400µ
13.	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

14.	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
15.	Insulated parts continuously exposed to condensing water	Sa 2 ½	In organic Zn silicate	2	75 µ							75µ
16.	For insulted piping <125^{0}C	Sa 2 ½	Polyamide cured epoxy coasting	2	250 µ							250µ
17.	Electrical parts, control panels, valves, pumps & motors (indoor)*	Sa 2 ½	Zn phosphate epoxy	2	80 µ				Chlorinated rubber	2	80 µ	160µ
18.	Electrical parts, control panels, valves, pumps & motors (outdoor)*	Sa 2 ½	Zn phosphate epoxy	2	80 µ				Chlorinated rubber	2	100 µ	180µ
19.	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.

CHAPTER – 8

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

1.0 General

1.1 The term "Performance Guarantees" wherever appears in the Technical Specifications shall have the same meaning and shall be synonymous to "Functional Guarantees". Similarly the term "Performance Tests" wherever appears in the Technical Specifications shall have the same meaning and shall be synonymous to "Guarantee Test(s)".

1.2 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.

1.3 The term "TMCR" (Turbine Maximum Continuous Rating) appearing in the Technical Specification shall mean 800 MW electrical power output at generator terminals (power at generator terminals) under 0% cycle make-up and guaranteed condenser pressure unless used in conjunction with a different cycle make-up and/or a different condenser pressure

2.0 Performance Guarantees/Performance Tests

2.1 General Requirements

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

2. 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.

3. The Bidder shall conduct performance test and demonstrate all the guarantees covered herein under Category I, II & III. Various tests which are to be carried out during performance guarantee tests are listed in this chapter. The guarantee tests shall be conducted by the Bidder at site in presence of OWNER.

4. 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.

5. It is the responsibility of the Bidder to perform the Performance Guarantee/Acceptance test as specified in this chapter.. At all times during the Performance Tests the emissions and effluents from the Plant shall not exceed the Guaranteed Emission and Effluent Limits.

6. 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 emissions and effluents from the Plant shall not exceed the Guaranteed Emission and Effluent Limits.

7. The Bidder shall make the plant ready for the performance guarantee tests.

8. All instruments required for performance testing shall be of the type and accuracy required by the code and prior to the test, the Bidder shall get these instruments calibrated in an independent test Institute approved by the Owner. All 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 Owner. The protecting tubes, pressure connections and other test connections required for conducting guarantee test shall conform to the relevant codes.

9. Tools and tackles, thermowells (both screwed and welded) instruments/devices including flow devices, matching flanges, impulse piping & valves etc. and any special equipment, required for the successful completion of the tests, shall be provided by the Bidder free of cost.

10. The Performance test shall be carried out as per the agreed procedure. The PG test procedure including demonstration tests shall be submitted within 90 days from the date of letter of intent and finalization of the PG test procedure shall be done within 180 days from the date of Letter of Intent. After the conductance of Performance test, the Bidder shall submit the test evaluation report of Performance test results to Owner promptly but not later than one month from the date of conductance of Performance test. However, preliminary test reports shall be submitted to the Owner after completing each test run.

    The final tests to prove the guaranteed performance parameters shall be conducted at site by the Bidder in presence of the Owner on the Unit. The Bidder's commissioning/start-up Engineer shall make the unit ready to conduct such tests. The Performance Guarantee Tests shall commence within 45 days after the successful completion of Trial Operation. The PG test shall conclude within 50 months from date of LOI Any extension of time beyond the above time shall be mutually agreed upon. These tests shall be binding on both the parties of the contract to determine compliance of the equipment with the guaranteed performance parameters.

11. 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.

12. The Bidder shall submit for Owner's approval the detailed Performance Test procedure containing the following:

    a) Object of the test
    b) Various guaranteed parameters & tests as per contract.
    c) Method of conductance of test and test code.
    d) Duration of test, frequency of readings & number of test runs.
    e) Method of calculation.
    f) Correction calculations & curves.

g) Instrument list consisting of range, accuracy, least count, and location of instruments.
h) Scheme showing measuring points.
i) Sample calculation
j) Acceptance criteria.
k) Any other information required for conducting the test.

13. **Test Reports**

After the conductance of Performance test, the Bidder shall submit the test evaluation report of Performance test results to Owner promptly but not later than one month from the date of conductance of Performance test. Preliminary test reports shall be submitted to the Owner 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 Owner for approval.

14. 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 the Owner and re-conduct the performance guarantee test(s) with Owner'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 within the Acceptable Shortfall Limit as specified at clause 3.2 of this Chapter, Owner will accept the equipment/system/plant after levying liquidated damages as per clause 3.2 of this Chapter. However, if, the demonstrated guarantee(s) continue to be beyond the stipulated Acceptable Shortfall Limit, even after the above modifications / replacements within ninety (90) days or a reasonable period allowed by the Owner, after the tests have been completed, the Owner will have the right to either of the following:

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 as indicated in clause 3.2 of this chapter shall be levied separately. The liquidated damages shall be prorated for the fractional parts of the deficiencies. The performance guarantees coming under this category shall be called `Category - I' Guarantees.

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 the payments already made.

OR

Accept the equipment/system after assessing the deficiency in respect of the various ratings, performance parameters and capabilities and recover from the contract price an amount equivalent to the damages as determined by the Owner. Such damages shall, however be limited to the cost of replacement of the equipment(s)/system(s), replacement of which shall remove the deficiency so as to achieve the guaranteed performance. These parameters/capacities shall be termed as "Category-III" Guarantees.

3.0 Guarantees Under Category-I

3.1 The Performance Guarantees which attract Liquidated Damages (LD) are as follows:

i. **Turbine Cycle Heat Rate**

a) Turbine Cycle heat rate in kcal/kWhr under rated steam conditions at guaranteed condenser pressure with zero make up at 440 MW unit load (i.e. 55% of rated load).

b) Turbine Cycle heat rate in kcal/kWhr under rated steam conditions at guaranteed condenser pressure with zero make up at 800 MW unit load (i.e. 100% of rated load).

ii. **Steam Generator Efficiency**

a) Efficiency of the steam generator at 105% TMCR (840 MW unit load) with zero make up while firing the design coal at rated steam parameters, rated coal fineness and rated excess air at economizer outlet.

b) Efficiency of the steam generator at 100% TMCR (800 MW unit load) with zero make up while firing the design coal at rated steam parameters, rated coal fineness and rated excess air at economizer outlet.

Note for (i) & (ii)

- Turbine Heat rate and Steam Generator efficiency shall be computed as per clause 3.4 and 3.7 respectively as under.
- PG test for Turbine cycle Heat Rate & Steam Generator Efficiency shall be conducted simultaneously.

Eg = Measured test efficiency corrected to the specified guarantee point flow.

Vg = Specified Guarantee point gas flow (m3/sec).

Vm = Measured gas flow (m3/sec)

Em = Measured test efficiency

Ln = Logarithm, natural base.

The correction curves should be realistic for expected range of operation and variation in characteristics specified.

The test efficiency shall be the average of at least three corrected test efficiencies.

However, method & detail procedure shall be subjected to Owner's approval.

3.8.4 The Performance tests shall be carried out in accordance with method-17 of EPA (Environmental Protection Agency of USA) code. The details of the test shall, however be mutually agreed upon between the Owner and the Bidder

3.9 AUXILIARY POWER CONSUMPTION

3.9.1 Unit Auxiliary Power Consumption

The unit auxiliary power consumption shall be calculated using the following relationship.

Pau = Pu + TL (Unit)
Pau = Guaranteed Unit Auxiliary Power Consumption.
Pu = Power consumed by the auxiliaries of the unit under test.
TL = Losses of the transformers supplied by bidder based on works test reports for unit.

The power consumption (Pu) of entire unit auxiliaries fed from unit transformers shall be measured at the incomers of respective unit boards. Suitable correction for auxiliaries not in service at the time of this measured power consumption like MDBFP etc, shall be done on as per the technical specification.

While guaranteeing the auxiliary power consumption the bidder shall necessarily include all continuously operating unit auxiliaries. The auxiliaries to be considered shall include but not be limited to the following:

(i) Turbine Unit Oil purifier.

(ii) Turbine Unit control oil purifier.

(iii) Electric oil heaters for turbine lube oil (if applicable).

(iv) Feed and discharge pumps of turbine oil purification system.

(v) Main turbine Condenser air evacuation pumps.

(vi) BFP drive turbine Condenser air evacuation pumps (if envisaged).

(xxxii) Seal Air Fans.

(xxxiii) Lube oil pumps for fans/ Air heaters & mill system etc

(xxxiv) Scanner air fans.

(xxxv) Electrostatic Precipitator with all TR sets , all hopper heaters including wrap around heaters of adapters, if applicable & all insulator heaters/pent house fans (if applicable) of all ESP passes working and rapping system in normal operation. During the test all hopper heaters including wrap around heaters of adapters, if applicable & all insulator heaters/pent house fans (if applicable)of all ESP passes will be in ON condition and set point temperature shall be kept 5 degree Celsius above the flue gas temperature. (Refer Note 4 below).

(xxxvi) Gas Recirculation Fan (if applicable)

(xxxvii) Circulating Water Pumps

(xxxviii) Power consumption of fans, water pumps, exhausters of Air washer units for TG building and whole main plant area at its rated duty point.

(xxxix) Power consumption of any other continuously operating BOP Packages viz., SCR, FGD, coal handling system, ash handling system, raw water system, water treatment plant, DM Plant, ETP, etc., for unit operation at 100% TMCR.

(xl) Pressurising pumps of fuel oil system.

(xli) Air conditioning and ventilation system

(xlii) Battery charger and UPS

(xliii) Limestone flow path and Duty factor for limestone handling plant shall be 0.2

(xliv) Gypsum flow path and Duty factor for gypsum handling plant shall be 1.0.

Note:

1. The bidder shall furnish a list of equipment to be covered under auxiliary power consumption, which shall be subject to Owner's approval.

2. The bidder shall ensure that power supply to all such equipment to be covered under auxiliary power consumption is fed from unit board.

3. Number of coal mill and coal feeders shall be corresponding to the design coal.

4. Method of Computation of Auxiliary Power consumption for ESP:-

   For guarantee purpose, total maximum continuous Auxiliary power consumption will be the power consumption of corona power (Excluding power consumption by hopper heaters, insulator heaters, rapping system, ventilation fans etc.) of all fields of all passes of ESP. Corona power of TR sets will be computed at the input terminals of the TR sets when all ESP fields of all ESP passes are working and rapping system is in normal operation at the guarantee point condition as

b) **Air Conditioning & Ventilation System - Duty Factor 1.0**

Power consumption at motor input terminals of working units (i.e., excluding stand-by) at its rated duty point of Chilling machines, Chilled water Pumps, Condenser water Pumps, Air handling unit (AHU) fans, for the Air conditioning system of main plant building, FGD control room, ESP control room of unit, AHP control room, service building, administrative building. Power consumption at motor input terminals of working units (i.e., excluding stand-by) at its rated duty point of compressor and condenser fans of air cooled condensing unit, Air handling unit (AHU) fans for the Air conditioning system of water system control building, switchyard control building and canteen building. Power consumption at motor input terminals of centrifugal fans of mechanical ventilation system of GIS building.

Power consumption at rated duty point for water cooled chillers & air cooled condensing units shall be based on site test and for other drives like chilled water pumps, condenser water Pumps & AHU centrifugal fans shall be based on shop test.

(Duty factor for power consumption of A/C equipment of service building shall be 0.5)

c) **Water System Pumps (Working Pumps) - Duty Factor 1.0**

i.) Raw Water Pumps for PT Plant
ii.) AHP Make up pumps
iii.) AC & Ventilation system make-up pumps
iv.) DM water make up pump
v.) Potable water pumps
vi.) Service water pumps.
vii.) Clarified water feed pumps for DM plant
viii.) Degassed water pump
ix.) Waste water transfer pumps
x.) Jockey Pumps for fire-fighting system
xi.) CT makeup pumps
xii.) CW and ACW pumps
xiii.) CW treatment system & Chlorination plant
xiv.) Sludge transfer pumps in PT Plant, Centrifuge and thickened sludge transfer pumps
xv.) Pumps (for ETP system, zero discharge system)
xvi.) Any other pump/drive required for continuous running of the station.

d) **Ash Handling System**

List of drives with corresponding weight age factors thereof for which power consumption (at reference design condition) is to be guaranteed shall be as follows:

Bidder's design shall ensure that the SO_x emission from FGD shall not exceed 80 mg/NM^3 (6% O_2 dry basis) under guarantee point condition.

5.0 GUARANTEES UNDER CATEGORY-III

The parameters/capabilities to be demonstrated for various systems/ equipment shall include but not be limited to the following:

5.1 Noise

5.1.1 All the plant, equipment and systems covered under this specification shall perform continuously without exceeding the noise level over the entire range of output and operating frequency.

5.1.2 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.

5.1.3 Sound pressure shall be measured all around the equipment at a distance of 1.0 m horizontally from the nearest surface of any equipment/ machine and at a height of 1.5 m above the floor level in elevation.

5.1.4 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

5.2 Start-up time

Start-up time (upto full load), and loading capabilities for the complete unit (boiler, turbine and generator together) for cold start, warm start and hot start conditions as agreed shall be demonstrated, ensuring that the various turbine operational parameters like vibration, absolute and differential expansion, eccentricity and steam metal temperature mismatch etc. are within design limits.

5.3 Performance characteristics of fans

Satisfactory operation of FD, ID and PA fans without undue noise and vibration while operating in isolation or in parallel with other fans shall be demonstrated at site.

5.4 Steam temperature imbalance

It shall be demonstrated at SH and RH outlets (in case of more than one outlet) that the temperature imbalance between the outlets does not exceed 10^0 C under all load conditions.

5.5 SH and RH tube metal temperature

It shall be demonstrated that superheater and reheater tube metal temperature at critical locations remain within maximum tube metal temperature limits as

one ID /FD /PA fan/ BFP etc.) shall be demonstrated ensuring smooth and stable runback operation.

For Details refer Volume II, Chapter-3.

(iii) Air Preheater Air in Leakage

Bidder shall demonstrate that the air-heater air-in-leakage and maximum drift in air leakage do not exceed the guaranteed or specified value (whichever is lower) as per indicated in the Technical specifications. Above requirement needs to be complied with recirculation of flue gas (if applicable) from downstream of ESP.

5.25 **Power Cycle Piping**

Actual hanger readings, under cold and hot condition (at rated parameters) to match with those of design cold and hot hanger readings for MS/CRH/HRH/ HP & LP bypass piping system.

5.26 **Air Conditioning & Ventilation System**

A. Following shall be demonstrated at Shop

1) Capacity and discharge pressure of chilled water pumps, condenser water pumps and pumps of air washer and unitary air filtration units at its rated duty point of Air conditioning and Ventilation system.

2) Capacity and static pressure of air washer unit fans, Unitary air filtration unit fans, roof exhausters of TG building and AHU fans at its rated duty point of Air conditioning and Ventilation system.

B. Following shall be demonstrated at Site

1) AC plant capacity of each area and guaranteed room conditions during summer for all the Air conditioned areas.

2) Parallel operation, Vibration & Noise level of all rotating equipment.

5.27 **Fuel Oil Handling System**

a) All pumps shall be guaranteed for capacity, total dynamic head either in isolation or during parallel operation.

b) Each storage tank shall be guaranteed for capacity and stability.

c) Entire piping and supports for smooth operation.

5.28 **Water System Pumps & other Misc. Pumps**

Capacity and head and power consumption of all the pumps at the rated duty point (to be demonstrated and proved at shop with the respective job motors).

Vibration, noise level and parallel operation of all the pumps at the rated duty point shall be demonstrated at site.

5.29 The parameters/capabilities to be demonstrated for following systems/ equipment shall be:

CHAPTER – 9

MANDATORY SPARES

1.0 SPARES

Bidder shall include in his scope of supply all the necessary Mandatory spares, start up and commissioning spares and recommended spares and indicate these in the relevant schedules of the Bid Form and Price Schedules. The general requirements pertaining to the supply of these spares is given below:-

1.1 MANDATORY SPARES

a) The list of mandatory spares considered essential is indicated in this Chapter. The bidder shall indicate the prices for each and every item (except for items not applicable to the bidders design) in the 'Schedule of mandatory Spares' whether or not he considers it necessary for the Owner 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 of each item in the Bid Forms and Price Schedules.

Whenever the quantity is mentioned in "sets" the bidder has to give the item details and prices of each item.

b) Owner reserves the right to buy any or all the mandatory spares parts.

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

d) All mandatory spares shall be delivered at site at least two months before scheduled date of initial operation of the Unit. However, spares shall not be dispatched before dispatch of corresponding main equipment.

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

f) Bidder shall clearly indicate either of the following against each spare specified in the list of mandatory spares.

1. Not applicable Equivalent Quoted
2. Not Required/ Not Applicable as per OEM Standard
3. Included

The above shall be indicated for each and every spare indicated in the specification. Bidder to note that in case spare is listed as 1 & 2 above and found to be required/ applicable in detailed engineering same shall be supplied without any implication.

1.2 **RECOMMENDED SPARES**

a) In addition to the spare parts mentioned above, the contractor shall also provide a list of recommended spares for 3 years of normal operation of the plant and indicate the list and total prices in relevant schedule of the Bid Form and Price Schedules. Owner 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 the unit. However, the spares shall not be dispatched before the dispatch of the main equipment.

b) Price of recommended spares will not be used for evaluation of the bids. The price of these spares shall remain valid up to 6 months after placement of Notification of Award for the main equipment. However, the Contractor shall be liable to provide necessary justification for the quoted prices for these spares as desired by the Owner.

1.3 **START-UP & COMMISSIONING SPARES**

Start-up and commissioning spares are those spares which may be required during the start-up and commissioning of the equipment/system. All spares used till the plant is handed over to the Owner shall come under this category. The Contractor shall provide for an adequate stock of such start up and commissioning spares to be brought by him to the site for the plant erection and commissioning. They must be available at site before the equipment are energized. The unused spares, if any, should be removed from site only after the issue of Taking Over certificate. All start up spares which remain unused at the time shall remain the property of the Contractor.

1.4 The Bidder shall include in his scope of supply all the necessary Mandatory spares, start up and commissioning spares and recommended spares and indicate these in the relevant schedules of the Bid Form and Price Schedules. The general requirements pertaining to the supply of these spars is given below.

1.5 The Contractor shall indicate the service expectancy period for the spares parts (both mandatory and recommended) under normal operating conditions before replacement is necessary.

1.6 All spares supplied under this contract shall be strictly inter changeable with the parts for which they are intended for replacements. The spares shall be treated and packed for long storage under the climatic conditions prevailing at the site e.g. small items shall be packed in sealed transparent plastic with desecrator packs as necessary.

1.7 All the spares (both recommended and mandatory) shall be manufactured along with the main equipment components as a continuous operation as per same specification and quality plan.

1.8 The contractor will provide Owner with cross-sectional drawings, catalogues, assembly drawings and other relevant documents so as to enable the Owner to identify and finalize order for recommended spares.

1.9 Each spares part shall be clearly marked or labeled on the outside of the packing with its description. When more than one spares part is packed in a single case, a general description of the content shall be shown on the outside of such case and a detailed list enclosed. All cases, containers and other packages must be suitably marked and numbered for the purposes of identification.

1.10 All cases, containers or other packages are to be opened for such examination as may be considered necessary by the Owner.

1.11 The contractor will provide the Owner with all the addresses and particulars of his sub suppliers while placing the order on vendors for items/components/ equipment covered under the contract and will further ensure with his vendors that the Owner, if so desires, will have the right to place order for spares directly on them on mutually agreed terms based on offers of such vendors.

1.12 The Contractor shall warrant that all spares supplied will be new and in accordance with the contract Documents and will be free from defects in design, material and workmanship.

1.13 In addition to the recommended spares listed by the contractor, if the Owner further identifies certain particular items of spares, the contractor shall submit the prices and delivery quotation for such spares within 30 days of receipt of such request with a validity period of 6 months for consideration by the Owner and placement of order for additional spares if the Owner so desires.

1.14 The Contractor shall guarantee the long term availability of spares to the Owner for the full life of the equipment covered under the contract. The Contractor shall guarantee that before going out of production of spares parts of the equipment covered under the Contract, He shall give the Owner at least 2 years advance notice so that the latter may order his bulk requirement of spares, if he so desires. The same provision will also be applicable to sub-contractors. Further, in case of discontinuance of manufacture of any spares by the Contractor and/or his sub-contractors, Contractor will provide the Owners, two years in advance, with full manufacturing drawings, material specifications and technical information including information on alternative equivalent makes required by the Owner for the purpose of manufacture/procurement of such items.

1.15 The bidder to provide datasheets/assembly drawings of the manufacturer/ any other relevant document showing Bill of Material(s), Make, Model Number, Part Number etc. through which the mandatory spares to be supplied can be uniquely identified. This would facilitate the Employer to assign a unique code to each of the mandatory spare as brought out in GCC. The bidder shall extend all necessary assistance in this regard.

NOTES:

1.0 Wherever quantity has been specified as percentage (%), it shall mean percentage (%) of the total population of the item in the station, unless specified otherwise and the fraction will be rounded off to the next higher whole number.

2.0 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.

3.0 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 list.

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 chapter. "Quality Assurance' is defined as the entire program 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 chapter. Contractor shall prepare the quality assurance plans for all the offered equipment 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 chapter. The Contractor shall utilize all of his QA/QC resources, manuals and procedures when preparing the plan. Owner shall review the plan prior to utilization and upon issue the plan shall become the basis by which Owner will evaluate the Contractor's engineering QA/QC activities as they relate to this project.

2.2 Owner's Participation

The Owner 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 Owner. 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 Owner reserves the right to review design details, either directly or through their Consultants. The Owner 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 Owner'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. Owner 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, Owner 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 **Owner's Participation**

2.4.3.1 The Owner 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 Owner can be present at particularly important stages of fabrication should the Owner wish to attend. The notification points are not hold points unless specifically identified as such. Should Owner select not to or fail to attend, the Work shall proceed without interruption. The Owner reserves the right, however, to make announced spot-checks to facilitate evaluation of the Sub-Contractor and/or the Contractor's inspection effort. Owner may wish to hold technical meeting with the machinery Sub-Contractor during the design and fabrication of the machinery. Should Owner desire to hold technical meetings, the Contractor will be advised at a reasonable notice.

2.4.3.2 During audit visits to fabricator shops, Owner may select to spot-check base materials and welds to verify proper metallurgy using whatever methods Owner 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 chapter.

2.4.4 **Communication**

2.4.4.1 Direct, timely communication between the Contractor's Inspectors and Owner's auditing Inspectors is mandatory, especially in notification points and in the event of problems, Owner 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 chapter. 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 e mailed by the Contractor's Inspector from works directly to Owner's Representative at the same time as e mailed to the Contractor's home office. Reports shall be e mailed to Contractor's home office for typing, editing and transmitting to Owner.

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. 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 Owner. 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 Owner 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 Owners 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 Owner. The following is a more detailed, but not inclusive, list of what Owner 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 Owner / 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 Owner 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 **Owner's Participation**

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

Owner'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. Owner'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 Owner's auditing Inspectors is mandatory. Further Owner 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 Owner'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 Owner 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 Owner'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 Owner'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 Owner'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 Owner 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 2.5.5. The field QA organization will be a full time organization, with no other construction-related duties. As with engineering and procurement, Owner 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 chapter 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. Hydro tests, 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 / Owner 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 Owner'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 chapter 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**

Owner 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 :

Attention:

Dear Sirs,

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

1.	Owner	:
2.	Project	:
3.	Owner'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 sincerely,

cc: Sub-contractor

QUALITY ASSURANCE PLAN FOR MECHANICAL

I N D E X

SECTION #	QUALITY ASSURANCE	No. of Sheets
M1.	Steam Generator & Auxiliaries	2
M2.	Steam Turbine Generator	23
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M5.	CW System	57
M6.	Air Conditioning & Ventilation System	60
M7.	Compressed Air System	65
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M11.	Coal Handling Plant	73
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M13.	Ash Handling System	88
M14.	Water Treatment & Water System	94
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SECTION - M6

AIR CONDITIONING & VENTILATION SYSTEM

1.0 CHILLING UNIT

1.1 REFRIGERANT COMPRESSOR (SCREW/SCROLL)

1.1.1 Hydraulic/Pneumatic test of castings for cylinder block / crank case / casings etc. shall be carried out. No leakage shall be permitted

1.1.2 DPT on connecting rod, piston, crankshaft, screw, Impeller with shaft, Vanes, crank case/cylinder/casing after machining shall be carried out.

1.1.3 All rotating parts of screw and centrifugal compressor shall be dynamically balanced to ISO 1940 Gr. 6.3.

1.1.4 Leak tightness & vacuum check for chilling units / compressors in assembled condition shall be carried out. No leakage shall be permitted.

1.1.5 Performance test of assembled compressor & Chiller Assembly shall be done to check for following :

a) Capacity test for oil pump for reciprocating compressor

b) No load air run (free run) test of all types of compressors / chilling units to check FAD (Free air delivery), Noise, and Vibration & Temp. rise of bearing & body. FAD is not applicable for Chiller

c) Pump up & leak back rate for reciprocating compressor.

d) Functional run test for Chiller assembly and Capacity control (for part load performance) check shall be carried out

1.2 CONDENSER & EVAPORATOR

1.2.1 DPT shall be carried out on finish welds.

1.2.2 10% RT of butt weld joints on shell shall be carried out.

1.2.3 Dimensional check including tube hole dia, ligament, pitch etc. shall be carried out.

1.2.4 Mock-up test for tube to tube sheet expansion shall be carried out. In case such a test is already conducted for similar tube/tube sheet thickness and materials, record for the same shall be furnished for review.

1.2.5 Hydraulic/Pneumatic test of Shell Side and Tube Side of condenser and evaporator as applicable shall be carried out. No leakage shall be permitted.

2.0 AIR HANDLING UNIT

2.1 20% DPT of welding on fan hub, blades, casing and impeller as applicable shall be carried out.

2.2 UT of fan shafts (dia greater than or equal to 50mm) shall be carried out.

2.3 DPT of fan shafts after machining shall be carried out.

2.4 DPT of welding on shaft (in case of fabricated shaft) shall be carried out.

2.5 Rotating Components of fan shall be statically and dynamically balanced to ISO 1940 Gr. 6.3

2.6 One fan of each type and size shall be performance tested as per AMCA / BIS for Air flow, Static Pressure, Speed, Efficiency, Power Consumption, Noise and Vibration.

2.7 One per type of assembled AHU (AHU casing & fan assembly) shall be subject to free run test. Noise, Vibration and Temp. Rise of bearing shall be measured during run test.

2.8 All cooling coil shall be pneumatically tested and no leakage shall be permitted.

3.0 CENTRIFUGAL PUMP

3.1 UT on pump shaft (dia. greater than or equal to 50mm), MPI/DPT on pump shaft and impeller after machining shall be carried out.

3.2 All rotating components of the pumps shall be statically and dynamically balanced to ISO-1940 Gr. 6.3

3.3 A standard hydrostatic test shall be conducted on the pump casing with water at 1.5 times the shut off pressure on the head Characteristics Curve or twice the rated pressure whichever is higher, for a minimum duration of 30 minutes.

3.4 Standard Running Test

a) All pumps shall be tested in the manufacturer's works preferably with contract motor for capacity, efficiency, head and brake horsepower. Pump shall be given running test over the entire operating range covering from the shut-off head to the maximum flow. The duration of test shall be minimum one (1) hr. A minimum of five readings approximately equidistant shall be taken for plotting the curves with one point at design flow. Testing of pumps shall be in accordance with stipulations of Hydraulic Institute Standard (HIS) and/or as per applicable Indian Standard or equivalent. Acceptance shall be as per approved datasheet & HIS standard only

b) Noise and vibration shall be measured at shop for reference purpose only.

c) Pumps shall be subjected to strip down examination visually to check for mechanical damages after testing at shop in case abnormal noise level and/or excessive vibration are observed during the shop test.

d) NPSH test shall be conducted with water as the medium, if required as per approved data sheets.

4.0 FANS

4.1 20% DPT of welding on fan hub, blades, casing and impeller as applicable shall be carried out.

4.2 DPT of fan shafts shall be carried out after machining.

4.3 UT of fan shafts (dia greater than or equal to 50mm) shall be carried out.

4.4 Rotating components of all fans shall be statically and dynamically balanced to ISO-1940 Gr. 6.3

4.5 All Centrifugal Fans shall be subjected to run test for 4 hrs. or till temperature stabilization is reached. Vibration, Noise level, Temp. rise and current drawn shall be measured during the run test.

4.6 One fan of each type and size will be performance tested as per corresponding IS code for Airflow, Static Pressure, Total Pressure, Speed, Efficiency, Power Consumption, Noise, Vibration and Temp. Rise.

5.0 LOW PRESSURE AIR DISTRIBUTION SYSTEM

5.1 Functional test for fire damper along with solenoid shall be done.

5.2 Prototype tests for fire resistance rating as per UL-555 of each type and size of damper shall be carried out. In case prototype tests have already been done, the contractor shall submit the test report for verification and approval.

5.3 SITE TEST:-After completion, all ducting system shall be checked/tested for air leakages/tightness (smoke test) at site.

6.0 INSULATION

6.1 Insulation material shall be tested for all mandatory tests only as per relevant code/standard.

6.2 Thermal conductivity tests (for thermal insulation only) shall be done once in six months for insulation material manufactured during six months period for the same density, outer diameter and thickness of material as applicable as per IS:3346 or equivalent standard.

7.0 COOLING TOWER

7.1 UT of fan shaft and drive shaft (dia greater than or equal to 50mm) shall be carried out.

7.2 DPT of fan hub and shafts shall be carried out after machining.

7.3 Colors of fills shall be as per approved data sheet.

7.4 Fan assembly shall be statically balanced.

7.5 Cooling Towers being supplied to site in assembled condition shall be subjected to run test at shop to measure FAD, Noise & Vibration. Cooling Towers being supplied in knocked-down condition, these tests shall be done at site.

8.0 AIR FILTERS

Pre/Fine filters shall be tested for initial and final pressure drop Vs flow and average synthetic dust weight arrestance as per the requirement of BS 6540/ASHARE-52-76/EN779. HEPA (Absolute) filters shall be tested as per applicable code.

9.0 PIPES & FITTINGS

9.1 Dye penetration test of welds of pipes / fittings (including welds of rolled and welded pipes, if any) shall be carried out.

9.2 All pipes and fittings shall be tested as per applicable codes/standards at manufacturer's works. Piping shall be tested at site hydraulically/pneumatically as per application requirement.

10.0 VALVES & SPECIALTIES

10.1 Visual and dimensional check of valves as per relevant code / approved drawing.

10.2 All the water line valves shall be hydraulically tested for body, seat and back seat (wherever provided) as per the relevant standard to which these valves are supplied irrespective of the working pressure for which these valves are selected. Check valves shall also be tested for leak tightness test at 25% of the specified seat test pressure.

10.3 Refrigerant line valves shall be pneumatically tested for body and seat leakage test.

10.4 All valves shall be offered for hydro test and pneumatic test in unpainted condition.

10.5 Functional check of the valves for smooth opening and closing shall be done.

10.6 Performance test to check pressure drop Vs flow shall be carried out for one valve of each type, size and rating for 'Balancing Valve'/Globe Valves with orifice.

10.7 One valve of each type, size and rating for 3-way mixing valve shall be subjected to cycle test for 500 cycles.

11.0 PACKAGED AIR CONDITIONERS (PAC)/ SPLIT/CASSETTE AC

11.1 For PAC Units, Split/Cassette Air conditioner up to 10 TR capacity will be accepted on the basis of Manufacturer Standard Guarantee and Warrantee certificate. However for these units capacity assessment shall be done at site as per approved procedures.

11.2 For Air Cooled PAC of Capacity more than 10TR, One Unit (Both indoors and out door interconnected) of each type and rating shall be subjected to production routine test inclusive of Performance Test as per IS: 8148 at prevalent ambient condition.

12.0 Air Washer and Unitary Air Filter (UAF)

12.1 Hydraulic test of pressure parts at 1.5 times the design.

12.2 Pressure and water fill test of tanks shall be carried out.

12.3 Random 10% DPT shall be carried out on weld joints

12.4 Trial assembly of Air washer/UAF for one of each size shall be done in shop.

1.4 BAG FILTERS

1.4.1 Leakage test shall be carried out for casing and other pressure parts

1.4.2 Pulsing and sequential test on bag filter cages shall be done.

1.5 MONO RAIL HOIST/CHAIN PULLEY BLOCKS

1.5.1 Chain pulley blocks shall be tested as per IS:3832

1.5.2 UT & MPI/DPT shall be done on gear blank, pinion shaft, axles.

1.5.3 Proof Load Test on hooks shall be carried out followed by DPT.

1.5.4 100% Radiography on weld joints under tension and 25% radiography on compression butt joints followed by 100% DPT shall be done for rope drum, girder, end carriage etc.

1.5.5 Complete hoists shall be tested for load and overload test as per IS:3177

1.6 VENTILATION SYSTEM

1.6.1 Shop Run Test for all Centrifugal Fans to check noise, temp. rise & vibration

1.6.2 Performance test on one fan of each type for capacity, pressure, efficiency and power consumption.

CHAPTER - 5

GENERAL TECHNICAL REQUIREMENTS

1.0 INTRODUCTION

This chapter 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 technicalspecifications and such proposals meet the specified design standards and performance requirement and are acceptable to the Owner. Sufficient amountof 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 ALL THE FACILITIES COMPLETED BEFORE FTO

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 equipment furnished by the Bidder shall be complete in every respect, withall 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 operatingpersonnel, 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.

4.4 For the C&I systems, the Contractor shall be required to provide regular information about future upgrades and migration paths to the Owner.

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 Boiler Act, 1923, and Rules and Regulations specified thereunder./GCC
c) Indian Factory Act, 1948, and Rules and Regulations specified thereunder. /GCC.
d) Indian Explosives Act, 1884, and Rules and Regulations specified thereunder. /GCC.
e) Indian Petroleum Act, 1934, and Rules and Regulations specified thereunder. /GCC.
f) ASME Test Codes./GCC
g) AIEE Test Codes./GCC
h) IEEE 122./GCC
i) IEC 34.1, 34.3./GCC
j) American Society of Materials Testing Codes./GCC
k) Bureau of the Indian Standards (BIS) ./GCC
l) Indian Electricity Act (2003)
m) Indian Electricity Rules
n) Indian Explosives Act
o) Indian Factories Act and State Factories Act
p) Indian Boiler Regulations (IBR)
q) Regulation of Central Electricity Authority
r) Regulations of the Central Pollution Control Board, India
s) Regulations of the Ministry of Environment & Forest (MOEF),
t) Pollution Control Regulations by Department of Environment, Government of India
State Pollution Control Board.
u) Building and other construction workers (Regulation of Employment and Conditions of services) Central Rules, 1998
v) Explosive Rules, 1983
w) Petroleum Rules, 1976,
x) Gas Cylinder Rules, 1981
y) Static and Mobile Pressure Vessels (Unified) Rules, 1981
z) Workmen's Compensation Rules, 1924
aa) Rules for Electrical installation by Tariff Advisory Committee (TAC) and appropriate Electrical Inspectorate.
bb) Owner’s Safety Policy
cc) Any other statutory codes / standards / regulations, as may beapplicable.

5.2 Unless covered otherwise by Indian codes & standards and in case nothing tothe 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 Organization 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 superiorto 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 wordtranslation of the standard that is normally not published in English.

5.4 As regards highly standardized equipment 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 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 theoriginal 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.

5.7 Two (2) English language copies of all national and international codes and/or standards used in the design of the plant and equipment shall be provided by the Contractor to the Owner within two calendar months from the date of the Notification of Award

6.0 **EQUIPMENT FUNCTIONAL GUARANTEE**

Please refer Chapter 8, Volume II

7.0 **DESIGN OF FACILITIES/MAINTENANCE AND AVAILABILITYCONSIDERATIONS**

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 equipment 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, 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 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.

7.2.4 Lifting devices i.e. hoists and chain pulley jacks, etc. shall be provided by the contractor for handling of any equipment or any of its part having weight in excess of 500 Kgs during erection and maintenance activities

8.0 **DOCUMENTS, DATA AND DRAWINGS TO BE FURNISHED**

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.

8.2 The Contractor shall furnish engineering data/drawings in accordance with the schedule of information as specified in Technical Specification and data sheets.

8.3 A comprehensive engineering and quality coordination procedure shall be finalized with the successful bidder covering salient features as described in this

section of specifications.

8.4 Each main and auxiliary equipment/item of the plant including instruments shall be assigned a unique tag number. The assignment of tag numbers shall be in accordance with KKS system. In all drawings/documents/data sheet etc. KKS tag number of the equipment/item/instrument etc. shall be indicated.

8.5 The number of copies/prints/manuals to be furnished for various types of documents is given in Volume II, Chapter 5, Annexure-VI.

8.6 The documentation that shall be provided by the Bidder is indicated in various chapters of specification. The documentation shall include but not be limited tothe following:

8.6.1 **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 LOI. 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/ equipment/ 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 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 LOI, 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.

8.6.2 **Detailed Engineering Documentation**

1) Layouts, general arrangements, elevations and cross-sections drawingsfor all the equipment and facilities of the plant.

2) The Contractor shall furnish a Plant Definition Manual within 12 weeks from the date of the LOI.

3) This manual shall contain the following as a minimum:

- Water Balance diagram.
- Flow diagrams, Process & Instrumentation Diagrams along with write-up and system description.
- 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.
- Piping isometric, composite layout and fabrication drawings.
- Piping engineering diagrams, pipe and fittings schedules, valve schedules, hanger and support schedules, insulation schedules.
- 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.
- 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.
- Boiler pressure part schedule and sizing calculations. Boiler performance data and boiler design dossier.
- Transient, hydraulic and thermal stress analysis of piping and system wherever applicable & input and output data along with stress analysis isometrics showing nodes.
- Thermal cycle information (heat balance diagrams, boiler performance calculations, condenser and heat exchanger thermal calculations etc.).
- Characteristic Curves/ Performance Correction Curves. Hydraulic & Mechanical design calculations for condensers & heaters.
- Model Studies for ESP & CW System.
- Characteristic Curves/ Performance Correction Curves and thermal design calculations for Cooling Tower.
- Composite Water Balance for total Plant.
- Hydraulic calculation/profile for Water Treatment Plant.
- 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.
- Power supply single line diagram, block logics, control schematics, electrical schematics, etc.
- Protection systems diagrams and relay settings.
- Interconnection diagrams.
- Cable routing plan.
- Instrument schedule, measuring point list, I/O list, Interconnection & wiring diagram, functional write-ups and 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.
- Alarm and annunciation list and alarms & trip set points.
- Sequence and protection interlock schemes.

- Type test reports and power system stability study report.
- Control system configuration diagrams and card circuit diagrams and maintenance details.
- Detailed software manuals & source software listing.
- Detailed flow chart for digital control system.
- Mimic diagram layout.
- Civil Task drawings, Design and Drawings for the Civil & Structural works in the scope of the Bidder.
- Model study reports wherever applicable.
- Functional & guarantee test procedures and test reports.
- Documentation in respect of Quality Assurance System as listed out elsewhere in this specification.
- 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.

8.6.3 **Instruction Manuals**

As per GCC

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 equipment 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 :

Chapter 1 - Plant Description

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 along with the intended system. (This 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 along with its accessories and auxiliaries.

v. Design data against which the plant performance will be compared.

vi. Master list of equipment, 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).

Chapter 2 - Plant Operation:

To contain the following sections specific to the equipment supplied

i. Protection logics provided for the equipment along with 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 along with 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 along with 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.

Chapter 3 - Plant Maintenance

To contain the following sections specific to the equipment supplied

i. Exploded view of each of the equipment. Drawings along with 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 along with checks to be carried out

vi. Overhauling schedules linked with running hours/calendar period along with checks to be done

vii. Long term maintenance schedules

viii. Consumables list along with 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 equipment have been supplied.

After finalization and approval of the Owner, 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 Owner.

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 Owner for records and number of copies shall be as mentioned in Annexure-VI.

8.6.4 **Plant Handbook and Project Completion Report**

8.6.4.1 **Plant Handbook**

The Bidder shall submit to the Owner a preliminary plant hand book preferablyin A-4 size sheets which shall contain the design and performance data of various plants, equipment 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, layout of main plant building, auxiliary buildings.
8) Important Do's & Dont's

The plant handbook shall be submitted within twelve (12) months from the date of LOI. After the incorporation of Owner's comments, the final plant handbook complete in all respects shall be submitted Six(6) months before start-up and commissioning activities.

8.6.4.2 Project Completion Report

The Bidder shall submit a Project Completion Report at the time of handing over the plant. (before Trial operation)

8.6.5 **Drawings**

a) i) All the plant layouts shall be made in computerized 3D modelling system. The Owner reserves the right to review the 3D model at

different stages during the progress of engineering. The layout drawings submitted for Owner's review shall be fully dimensioned and extracted from 3D model after interference check.

ii) All documents submitted by the Contractor for Owner's review shall be in electronic form (soft copies) along with the desired number of hard copies as per Annexure-VI.

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 requisitenumber of hard copies shall be submitted as per Annexure-VI.

b) All documents/text information shall be in latest version of MS Office orMS 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 equipment andmaterials, 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 Owner, 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) Contractor shall prepare the model of all the facilities located within plant boundary covering facilities in Main Plant Block area and Balance of plant (BOP) area in an integrated & intelligent 3D software solution. Main Plant Block area shall include Transformer Yard, TG building (including all facilities), Boiler area, ESP area, chimney area, FGD area and any other facility located in main plant block. BOP area shall include all facilities pertaining to AHP, CHP, LHP, GHP, DM PT plant, pipe & cable racks and any other facility located within plant boundary.

All piping layouts, equipment layouts, floor plans, ducting layout (Air/flue gas, A/C, Ventilation etc.), General Arrangement drawings and RCC layout of major buildings and structural arrangement drawings shall necessarily be extracted from the aforesaid 3D model.

Contractor shall prepare and provide 3D design review model (network ready, which shall include visual interference check, walk-through animation, video simulation for major equipment placement and removal, visual effect, photo realism etc.), which is extracted from intelligent 3D model and shall make a presentation of the same every 3 months from LOA to enable OWNERS ENGINEERING to review the progress of engineering or as & when required by Owner.

f) The drawings submitted by the Contractor (or their sub-vendor) shall bear Owner's drawing number in addition to contractor's (their sub- vendor's)

own drawing number.

g) 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 Owner. Such list should clearly indicate the purpose of submission of these drawings i.e. "FOR APPROVAL" or "FOR INFORMATION ONLY".

h) 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 beidentified on each drawing for Approval stamp and electronic signature.

i) 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 Owner will cover only general conformance of the data/drawings/documents to the specifications and contract, interfaces with the equipment provided by others and external connections & dimensions which might affect plant layout. The review by the Owner should not be construed to be a thorough review of all dimensions, quantities and details of the equipment, materials, any devices or items indicated or the accuracy of the information submitted. The review and/ or approval by the Owner/ Project Manager shall not relieve the Contractor of any of his responsibilities and liabilities under this contract.

j) 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 Owner.

k) 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 Owner.

l) 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 Owner indicating the reasons for the change and get the revised drawing approved again in strict conformance to the provisions of the Technical Specification.

m) 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.

n) 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 systemcharging and its effective draining & venting arrangement as per site suitability.

o) **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.

p) 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.

q) 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.

r) 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 technicalspecifications unless otherwise expressly requested by the ProjectManager in writing.

8.7 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 along with 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 categorized 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 tothe Owner, 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.

8.8 **Engineering Progress and Exception Report**

8.8.1 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.

8.8.2 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.

8.8.3 Provision for Fail Safe operation of vital Equipment

All the Plant and equipment/Systems supplied under the contract shall be designed following "Fail Safe" concept. In case of failure of Power supply like Electric power, Hydraulic pressure, Pneumatic pressure, Vacuum etc. the system should be designed in such a way that the equipment/Valves/dampers etc. shall always move/remains (as applicable) to safest position as per system requirement to ensure safety of Man and Machinery.

8.9 **Engineering Co-ordination Procedure**

8.9.1 The following principal coordinators will be identified by respective organizations at time of award of contract:

Project Manager (HPGCL CE-TD)

Name		:
Designation		:
Address		
a)	Postal	:
b)	Telegraphic /e-Mail	:
c)	FAX/TELEPHONE	:

Project Consultant (Desein)

Name		:
Designation		:
Address		
a)	Postal	:
b)	Telegraphic /e-Mail	:
c)	FAX/TELEPHONE	:

Contractor's/ Vendor's Engineering Coordinator (VENDOR EC):

Name		:
Designation		:
Address		:
a)	Postal	:
b)	Telegraphic /e-Mail	:
c)	FAX/TELEPHONE	:

8.9.2 All engineering correspondence shall be in the name of above coordinators on behalf of the respective organizations.

8.9.3 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 finalized 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 sub vendor'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 sub vendor along with hispurchase order for sub vendor's compliance.

d. Owner and contractor shall follow their own numbering systems for the drawings. However, Owner shall intimate the contractor, OWNER drawing number on receipt of the first submission of each drawing. Vendor, thereafter, shall indicate OWNER drawing number in subsequent Submission, in the space provided for this purpose in title plate, in addition to his own drawing number.

e. The contractor shall make a visit to site to see the existing facilities and understand the layout completely and collect all necessary data /drawings at site which are needed as an input to the engineering. The contractor shall do the complete engineering including interfacing and integration of all his equipment, systems & facilities within his scope of work as well as interface engineering & integration of systems, facilities,equipment & works under 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/documentfor 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:

The Contractor shall submit drawing / data / document for Owner's review and approval. The drawings submitted by the Contractor/vendor shall be reviewed by OWNERS ENGINEERING and their comments shall be forwarded within three (3) weeks of receipt of drawings. Upon review of each drawing, depending on the correctness and completeness of the drawing, the same will be categorized and approval accorded in one of the following categories:

CATEGORY A : Approved

CATEGORY B : Approved, subject to incorporation of comments/ modification as noted. Resubmit revised drawing incorporating the comments

CATEGORY C : See MEMO & COMMENTS

CATEGORY D : Not approved. Resubmit revised drawings for approval after incorporating comments/ modification as noted.

CATEGORY E : For information and records.

After **Rev 0** comments, the drawing will be locked in the system. Contractor will review the Rev 0 comments within 7 days & furnish the Comment Reply Sheet (CRS) to OWNERS ENGINEERING as an agenda point for TCM. TCM shall be conducted with Contractor on non-agreed comments of CRS.

System will not allow Contractor to submit approval category drawings before the scheduled submission date. However, documents may be unlocked on case to case basis. Based on resolution of all comments and agreements, the document will be approved in TCM itself. The contractor will revise the document based on the resolutions and certify that all the resolutions has been taken care of. Based on this certification, the document will be opened and submitted by contractor in the system for approval as Rev 1 within 10 days of TCM.

1. Contractor shall resubmit the drawings marked/stamped under Category B, C & D within three (3) weeks of receipt of comments on the drawings, incorporating all comments. Every revision of the drawing shall bear a revision index wherein such revisions shall be highlighted in the form of description or marked up in the drawing identifying the same with relevant revision Number enclosed in a triangle (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 theportions 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 arerevised marking the relevant revision numbers and Owner shall review only such revised portion of documents**.

2. In case, the Contractor/ Vendor does not agree with any specificcomment, he shall furnish the explanation for the same to OWNER for consideration. In all such cases, the Contractor shall necessarily encloseexplanations along

with the revised drawing (taking care of balance comments) to avoid any delay and/or duplication in review work.

3. 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.

4. 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 outon the basis of comments furnished on previous issues of the drawing.

5. These comments will be taken care by the contractor while submitting the revised drawing.

6. The contractor shall use a single transmittal for drawings Submission. This shall include transmittal numbers and date, number of copies beingsent, names of the agencies to whom copies being sent, drawing numberand 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 suchmeetings at his own cost at mutually agreed venue as and when required andfully 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 Owneras 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 tableduring the above co-ordination Meetings wherein best efforts shall be made byboth sides to ensure the approval of the drawing.

9.3 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 four (4) 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 completiondate.

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

As per **Clause 28.10, Section V - E**CC **of Volume I**.

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 shall include chemicals 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 shallbe in accordance with the requirements of this specification. Materials utilizedfor 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 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/cm^2 (abs).

d) Blow down 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 liters 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

As per Erection Conditions of Contract

18.0 WELDING

As per Erection Conditions of Contract

19.0 COLOUR CODE FOR ALL EQUIPMENT/PIPING/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

As per Erection Conditions of Contract

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. DFT of each coat shall be 40 microns.

20.2.2 Transformers and other electrical equipment 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 950 C 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 950 C 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 Owner's site or at any other place of workare 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 Owner /authorized 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 thefollowing:

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-vendor'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 authorizing 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 shallbe procured, manufactured, erected, commissioned and tested at all the stages, as per a comprehensive Quality Assurance Program. An indicative program 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 program as it is the Bidder's responsibility to draw up and implement such program duly approved by the Owner. The detailed Quality Plans for manufacturing and field activities shall be drawn up by the Bidder and shall be submitted to Owner for approval. Schedule of finalisation of such quality plans shall be finalised before award. Monthly progress reports on MQP/FQP submission/approval shall be furnished.

22.2 Manufacturing Quality Plan shall 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-vendor'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 authorized 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 dispatched from the manufacturer's works before the same is accepted, subsequent to pre dispatch final inspection including verification of records of all previous tests/inspections by Owner's Project Manager/ Authorized representative and duly authorized for dispatch by issuance of Material Dispatch 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 activities in 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 leastninety 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 authorized 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-vendor'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/authorized 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-vendor 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 finalized 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-vendor 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 contractor 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-vendor shall set out, during the various stages of manufacture and installation, the quality practices and procedures followed by the vendor's quality control organization, the relevant reference documents/standards used, acceptance level, inspection of documentation raised, etc. Such quality plans of the successful vendors shall be finalized with the Owner and such approved Quality Plans shall form a part of the purchase order/contract between the Bidder and sub-vendor. 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-vendor'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 program during manufacture in his work and that of his sub-vendor'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/ authorized representative.

22.25 **Environmental Stress Screening**

Environmental stress screening test process / procedure for eliminating infant mortile components for DDCMIS / PLC based system & for other systems having substantial electronics components (as determined by Owner) like Electronic transmitter, CCTV components, PA systems etc. shall be furnished for OWNERS ENGINEERING acceptance.

The Contractor / Sub-contractor shall carry out routine test on 100% item at contractor / sub-contractor's works. The quantum of check / test for routine & acceptance test by 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.

22.25.1 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

22.25.2 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 ElevatedTemperature Cycle Test as per the following procedure.

23.0 **Software Reliability / Quality Certification**

Certification from OEM's authorized signatory that software offered with DDCMIS, PLC, CCTV, PA, Pyrometer, CEMS, AAQMS, EQMS, BHMS etc. declaring that the all the offered software(s) had gone through the established software quality test and offered software is not of β-version and offered software is also free from all known bugs as on date of approval of systems documents by OWNERS ENGINEERING as a part of quality documentation review and approval process during detail engineering.

24.0 **QA Documentation Package**

24.1 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.

24.2 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.

24.3 The QA Documentation file shall be progressively completed by the Supplier's sub- supplier to allow regular reviews by all parties during the manufacturing.

24.4 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.

24.5 Typical contents of QA Documentation are as below:-

a) Quality Plan
b) Material mill test reports on components as specified by thespecification 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

24.6 Similarly, the Bidder shall be required to submit two sets (two hard copies andtwo CD ROMs), containing QA Documentation pertaining to field activities as per Approved Field Quality Plans and other agreed manuals/ procedures, priorto commissioning of individual system.

24.7 Before dispatch / 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 iscompleted. 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 dispatch, whereas all outstanding actions cannotbe readily cleared for the release of the quality document by that time.The supplier shall immediately, upon shipment of the equipment, senda 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 dispatch of equipment.

24.8 **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 otherset to respective Project Site of Owner.

For the particular case of phased deliveries, the complete quality document tothe Owner shall be issued not later than 3 weeks after the date of the last delivery of equipment.

25.0 **PROJECT MANAGER'S SUPERVISION**

25.1 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.

25.2 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 authorized 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 Program implementation at all stages of the works.

26.0 **INSPECTION, TESTING AND INSPECTION CERTIFICATES**

As per SCC

26.1 **Associated document for quality assurance program:**

26.1.1 List of items requiring quality plan and sub supplier approval. (Annexure-III).

26.1.2 Status of items requiring Quality Plan and sub supplier approval (Annexure-IV)

26.1.3 Field Welding Schedule (Annexure-V).

26.1.4 Manufacturing Quality Plan (Annexure-I).

25.1.5 Field Quality Plan (Annexure-II).

26.2 **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 a w a r d . 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, representativeof

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.

26.2 **Demonstration of Application Engineering**

26.2.1 Based on Owner's 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 alongwith 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).

26.2.2 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 OWNER's 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 theOwner 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 Ownerpremises & the results shall be documented as part of test report.

26.2.3 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.

27.0 PRE-COMMISSIONING, COMMISSIONING, TRIAL OPERATION, PERFORMANCE TEST

As per Section VI-SCC of Volume I.

27.1 Initial Operation/Trail Operation Test

As per Section VI-SCC of Volume I.

27.2 Guarantee Tests

As per Chapter 8, Volume II.

28.0 FINAL TAKING OVER

As per Section VI-SCC of Volume I.

29.0 TRAINING OF OWNER'S PERSONNEL

The scope of service under training of Owner shall include a training module in the areas of Operation & Maintenance. Total period for above training shall not be less than sixty (60) man-months at manufacturers' works & facilities.

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 equipment.

b) Training for Electric Systems including VFD and Electric power supply system.

c) Training for other SG/TG related C&I systems/equipment 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 finalized during detailed engineering and shall be subject to Owner's approval.

29.1 The scope of services under training shall also necessarily include training of Owner's 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 soft-wares 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.

29.2 Contractor shall also arrange for training of Owner's personnel in respect of fire detection and protection systems and other Balance of Plant equipment.

29.3 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.

29.4 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 re-appropriate the training period between O&M and engineering depending upon the details of training module proposed by the Bidder.

29.5 Exact details, extent of training and the training schedule shall be finalized by the Owner based on the Bidder's proposal.

29.6 In all the above cases, wherever the training of Owner's personnel is arranged at the works of the manufacturer's (within Owner’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.

29.7 In case the training of Owner's personnel is arranged at the works of the manufacturer's (outside Owner’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.**

Note: For training purposes, one (1) man month implies 30 working days (excluding all intervening holidays) per person.

30.0 **SAFETY ASPECTS DURING CONSTRUCTION AND ERECTION**

As per Section V- ECC, Volume I

31.0 **NOISE LEVEL**

As per Chapter 8, Volume II.

32.0 **PACKAGING AND TRANSPORTATION**

As per Section IV-GCC, Volume I

33.0 **ELECTRICAL EQUIPMENT/ENCLOSURES**

All electrical equipment 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.

34.0 **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.

34.1 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 (MMWC).
d)	Vacuum	-	Millimeters of mercury column (mm Hg) or water column (MMWC).
e)	Flow (Gas)	-	Tonnes/ hour
f)	Flow (Steam)	-	Tonnes/ hour
g)	Flow (Liquid)	-	Tonnes / hour
h)	Flow base	-	760 mm Hg. 15^0 C
i)	Density		Grams per cubic centimeter.

34.2 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.

34.3 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.

35.0 **ELECTRICAL NOISE CONTROL**

The equipment furnished by the Bidder shall incorporate necessary techniquesto 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 theproposal. The equipment shall be protected against ESD as per IEC-801- 2./ IEC 61000-2 Radio Frequency interference (RFI) and Electro Magnetic Interference (EMI) protection against hardware damage and control system mal-operations/errors shall be provided for all systems.

36.0 **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 powerplant 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.

37.0 **INSTRUMENT AIR SYSTEM**

The instrument air supply system as supplied by the Bidder for various pneumatic control & instrumentation devices like pneumatic actuators, powercylinders, 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.

38.0 **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

39.0 **SYSTEM DOCUMENTATION (DDCIMS)**

39.1 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 DataSheets" Part of specifications. In addition to this, system documentation for DDCMIS shall include as a minimum to that specified elsewhere in the TechnicalSpecification.

39.2 The exact format, submission schedule and contents of various documents shall be as finalized during detailed engineering stage.

39.3 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.

40.0 MAINTENANCE MANUALS OF ELECTRONIC MODULES

The Contractor shall furnish 2 SETS OF all maintenance manuals 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.

41.0 ENVIRONMENTAL MONITORING & CONTROL MEASURES

41.1 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 contaminationof soil, water and air.

41.2 One single flue stack of minimum 150 M will be provided for wider dispersion of pollutantas per environmental guidelines.

42.0 LIST OF CODES AND STANDARDS

Indian Standards	Title	Equivalent standards
IS: 277	Galvanised steel sheets (plain or corrugated)	
IS: 655	Specification for metal air duct	
IS: 800	Code of practice for	BS 449:1969
	use of structural	BS 5950
	steel in general	ASA A57,
	building construction 1-1952	
IS: 807	Code of practice for	Draft Revision,
	design, manufacture,	A.S. NO. CS.2
	erection and testing	SAA Crane and
	(Structural portion)	Hoist code
	of cranes and hoists	Doc:No. BU/4 Rev

	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 1757:1951BS 2573:part-I:1960	
IS:875	Code of practice for design loads (other than Canada earthquake) for buildings and structures Leading standards by Canadian Standard) DIN-1055-1955 (Issued by ASA)	National Buildingcode of (1953)-Part-IV Design section 4.1 (issued
IS:1239 Part-I	Mild steel tubes	(ISO/R 65-1957)(ISO/R-64-1958) (ISO/R-65-1958) (BS 1387 : 1957)
IS:1239	Mild steel tubulars and	BS 1387 : 1967
Part-II	other wrought steel pipe fittings	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 mono crystallinesrectifire 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 PVC sheathed cables No. 5-66-524	Standard No. 1 to insulated IPCEA (USA) Pub.
IS:7373	Specification for wrought aluminium and aluminium sheet and strips	
IS:7938	Air receivers for compressed air installation	
ISO:1217	Displacement compressor-Acceptance 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 particulate 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 & reinforcedconcrete 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	Specification for preformed fillers for expansion joints in concrete (Part-I) 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 Allied Works

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 withrotating 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 socket weld 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.

		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"		DOC. NO.: REV…… CAT…..
MANUFACTURER / SUB-SUPPLIER	MAIN-SUPPLIER		FOR THE OWNER USE	
SIGNATURE				REVIEWED BY / APPROVED BY / APPROVAL SEAL

ANNEXURE - II

SUPPLIER's LOGO	SUPPLIER'S NAME AND ADDRESS		FIELD QUALITY PLAN ITEM : SUB-SYSTEM :	QP NO.: REV.NO.: DATE: PAGE: .... OF....				PROJECT : PACKAGE : CONTRACT NO. : MAIN-SUPPLIER :		
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, **'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.....		
MANUFACTURER/ SUB-SUPPLIER		MAIN-SUPPLIER				FOR THE OWNER USE				
SIGNATURE								REVIEWED BY	APPROVED BY	APPROVAL SEAL

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 "Details 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 comm t Appl.	Status Code C/II/I	Proposed Sub-suppliers	Place of manufacturing 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

DISTRIBUTION SCHEDULE

S.No.	Description of Document	DESEIN				HPGCL			
		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	4*	1	-	-	2	1	-	-
2.	Final Approved Documents	1	1	1	1	1	1	4	1
3.	Drawings / Documents 'As Built'	1	1	1	1	2	1	4	1
4.	Type Test Reports (Initial)	4*	1	-	-	2	1	-	-
5.	Type Test Report (Final)	2**	1	1	1	2	1	4	1
6.	Piping / Equipment Analysis (Transient) etc., Model Study Report (Draft) including Input / Output date etc.	4*	1	-	-	2	1	-	-
7.	Piping / equipment Analysis (Transient) etc. Model Study Report (Final Approval) including Input / Output date	2**	1	-	-	2	1	2	1
8.	Erection Manual (Draft)	4*	1	-	-	1	1	-	-
9.	Erection Manual 'Final'	1	1	1	-	1	1	2	1
10.	O&M Manual 'Draft'	4*	1	1	-	1	1	-	-
11.	O&M Manual 'Final'	1	1	1	-	1	1	2	2
12.	Commissioning Procedure 'Draft'	4*	1	-	-	1	1	-	-
13.	Commissioning Procedure 'Final'	2**	1	1	-	1	1	2	1

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

* - Consultant will return two (2) stamped document to CE (TD) HPGCL
** - Consultant will return one (1) stamped document to CE (TD) HPGCL
HC - Hard Copy
CC - Soft Copy thru e-mail
HO - Head Office of Consultant/HPGCL

ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
	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 equipment & systems shall be decided during detailed engineering.			
CONTROL & INSTRUMENTATION				
DDCMIS-Man Machine Interface - Hardware &	Hardware & Software organization of the system Basis of selection of H/W memory sizing	Operational feedback		

CHAPTER – 27

LOW PRESSURE PIPING, VALVES & SPECIALITIES

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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/Sec 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 – 15M/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 diameter so established, thickness calculation shall be made as per ANSI B 31.1. OD and thickness of pipes shall then 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 300 NB size may be butterfly valves.

27.1.14 Recirculation pipes alongwith valves, breakdown orifices etc. shall be provided for important pumping systems as required. 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 Technical Specification

27.2.1 General

Specific technical requirements of low-pressure piping, fittings, supports, valves, specialties and tanks etc. have been covered under this Chapter. 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.

27.3 Pipes and fittings

27.3.1 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 calculations as per the criteria mentioned above under LP piping equipment sizing criteria of this Technical Specification.

27.3.2 Piping and fittings coming under the purview of IBR shall be designed satisfying the requirements of IBR as a minimum.

27.3.3 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 shall submit the detailed drawings for thrust/anchor block. External, and internal, attachments to piping shall be designed so as not to cause flattening of pipes and excessive localized bending stresses.

27.3.4 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).

27.3.5 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.

27.3.6 Piping and fittings shall be manufactured by an approved manufacturer. They shall be truly cylindrical of clear internal diameter, of uniform thickness, smooth and strong, free from dents, cracks and holes and other defects.

27.3.7 For rubber lined ERW pipes, beads shall be removed.

27.3.8 Inspection holes shall be provided at suitable locations for pipes 800 NB and above as required for periodic observations and inspection purposes.

27.3.9 At all intersection joints, it is Contractor's responsibility to design and provide suitable reinforcements as per the applicable codes and standards.

27.3.10 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 valves on certain long distance/high volume piping systems such as CW/ ACW/ Raw Water etc.

27.4 **Material**

27.4.1 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.

27.4.2 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.

27.4.3 All materials shall be new and procured directly from the manufacturers. Materials procured from traders or stockiest are not acceptable.

27.4.4 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.

27.4.5 Material of construction for pipes carrying various fluids shall be as follows:

1	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. At road crossings live loads shall be considered and pipe thickness shall vary accordingly. 150 NB & above pipes shall be spiral welded.
2	Dematerialized water, (condenser Make up water,	Stainless steel to ASTM A-312, Gr. 304 welded for sizes above 50mm

	Boiler fill and Deaerator Fill water) & DMCW overhead tank make-up water	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 SI-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 SI-4736 or equivalent.
5.	Fuel Oil piping	API5L

NOTE: Bidder to note that for Effluent disposal system and potable water system (* 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 is mentioned in Annexure-I.

27.4.6 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 dematerialized water, drinking water and condensate spill lines.

27.4.7 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).

27.4.8 In dematerialized 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., dimensions, tolerances, manufacturing methods, material, heat treatment, testing requirements, etc. unless otherwise mentioned elsewhere in the specification.

27.4.9 Instrument air, 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 Heavy grade, 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).

27.4.10 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.

27.4.11 Condensate lines shall be to ASTM A 106 Gr. B and dimension to ANSI B 36.10 schedule "standard" as minimum to be maintained.

27.4.12 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.

27.4.13 Buried CW Pipes shall be encased in 500 mm thick RCC. However this thickness shall be reviewed for live loads at road crossings according to AWWA M11 and adequately revised.

27.5 Piping Wall Thickness

27.5.1 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 1.0 mm shall be considered while selecting the thickness.

27.5.2 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)	20 (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

27.6 Piping Layout

27.6.1 Piping shall be grouped together where practicable and routed to present a neat appearance.

27.6.2 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.

27.6.3 Over head piping shall have a normal minimum vertical clearance of 2.5 M above walkways and working areas and 8 M above roads/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.

27.6.4 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 for 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.

27.6.5 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.

27.6.6 Adequate clearance shall be ensured with respect to the above to accommodate insulation and pipe movements, if any.

27.6.7 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.

27.6.8 Sufficient up stream and down stream lengths shall be provided for flow measuring devices, control valves and other specialties.

27.6.9 All local instruments shall be located on pipelines as to render them observable from the nearest available platforms.

27.6.10 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.

27.7 Slope/Drains and Vents

27.7.1 Suitable slope shall be provided for all pipelines towards drain points. It is bidder's 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. Vents shall not be less than 25 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.

27.7.2 Air piping shall be sloped so that any part of the system can be drained through the shut-off drain valve or drain plugs.

27.8 **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.

27.8.1 **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.

(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.

27.8.2 **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.

27.8.3 **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.

27.9 **Bends/elbows/mitre bends/Tees/Reducers & other fittings**

27.9.1 Unless otherwise specified elbows shall be of long radius type.

27.9.2 For pipe sizes 50 NB and below, 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.

27.9.3 For steel pipes 65 NB and above, seamless long radius forged elbows shall be used. For pipe sizes 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 degree 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/BS:534.

27.9.4 Mitre bends are not acceptable in case of rubber lined mild steel pipes.

27.9.5 For pipe fittings such as reducers and 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.

27.9.6 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.

27.9.7 In no case, the thickness of fittings shall be less than the thickness of parent pipe, irrespective of material of construction.

27.10 **Flanges**

27.10.1 Flanges shall be slip on type. Welding of flanges in tension is not permitted.

27.10.2 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.

27.11 **Specific technical requirement of laying buried pipe with anti corrosive treatment**

The pipe in genera, shall be laid with the top of the pipe minimum 1 M below finished ground level.

27.11.1 **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.

27.11.2 **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 250 mm for joints, which shall be coating manually at site after laying, welding and testing the pipe.

27.11.3 **Coating and wrapping/ Anti corrosive Protection Coal tar tape**

a. Buried piping shall be coated and wrapped, 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 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.

27.11.4 **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.

27.11.5 **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.

27.12 **Cleaning and Flushing**

27.12.1 All piping shall be cleaned by the Bidder before and after erection to remove grease, dirt, dust, scale and welding slag.

27.12.2 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.

27.12.3 After erection, all water lines shall be hydro tested at 1.5 times the design pressure.

27.12.4 All compressed air pipe work shall be cleaned by blowing compressed air.

27.13 **Painting of Pipes**

27.13.1 **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. Pipes external surface shall be applied with one coatsof coal tar primer before placing the pipes in position for RCC encasing. Thickness of paint shall be minimum 35 microns.

Tests to be carried out after application: Bond/ Adhesion test, Holiday test.

27.13.2 **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).

27.13.3 **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 is 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.

27.13.4 **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.

27.14 **Specification for hangers and supports**

27.14.1 All supports and parts shall conform to the requirement of power piping code ANSI B 31.1 or approved equivalent.

27.14.2 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.

27.14.3 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.

27.14.4 Hangers, saddles, supports etc. shall be fabricated from plates/pipes sections conforming to ASTM A 53/IS: 2062 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.

27.14.5 The support shall be interspaced as to minimize sagging of the pipes and to keep them with in permissible limits where pipes are full with the conveying media.

27.14.6 The maximum spans of the supports of straight length shall not exceed the recommended values indicated in ANSI B 31.1.

27.14.7 All pipe supports shall be designed to provide an absolute minimum head room of 2.5 m from floor in passages/walkways.

27.14.8 At all sliding surfaces of supports suitable arrangement is to be provided to minimize sliding friction.

27.14.9 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.

27.15 **Design/Construction/Material Particulars of Gate/ Globe/ Check Valves/ Butterfly Valves**

27.15.1 **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 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 Dual plate 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 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 platforms for facilitating easy valve operation shall be provided wherever necessary.

(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.

27.15.2 **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.

27.15.2.1 The design, material, construction, manufacture, inspection, testing and performance of valves shall comply with all currently applicable statutes, regulations and safety codes n 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

27.15.2.2 **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

27.15.2.3 All cast iron body valves (gate, globe and non-return) shall have flanged end connections.

27.15.2.4 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.

27.15.2.5 All gun metal body valves shall have screwed ends.

27.15.2.6 All flanged end valves/specialties shall be furnished alongwith matching counter flanges, fasteners, gaskets etc. as required to complete the joints

27.16 **Check Valves**

27.16.1 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.

27.16.2 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.

27.16.3 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.

27.16.4 Counter flanges to be installed on air pipes shall be screwed-on type irrespective of size.

27.17 **Globe Valves**

27.17.1 The globe valves shall have the following characteristics:

Straight conveyed flow; Right angle; Preferably, the valves shall be of the vertical stem type.

27.17.2 Globe valves shall preferably have radiused or spherical seating and discs shall be free to revolve on the spindle.

27.17.3 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.

27.17.4 For the regulating valves, valves with regulating plug & parabolic outline disc type is preferred.

27.17.5 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.

27.18 **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.

27.19 **Air Release Valves**

(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 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	:	SS
Cover packing	:	Braided asbestos
Float	:	Wood/rubber

27.20 **Butterfly Valves**

27.20.1 **Design/Construction**

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 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.

27.20.2 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 CI IS 210 Gr FG 260
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/ Eq.
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/Eq
Disc & Seat Rings	EPT/BUNA-N/Neoprene

27.20.3 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.

27.21 **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	ASTM A 216 Gr. WCB/
Trim.	ASTM A 182 Gr. F6 or Equivalent

(2) Stainless Steel Valves

Body & Bonnet/Disc	ASTM A 351 Gr. CF 8M/ ASTM A 182 Gr. 304
Trim.	ASTM 182 Gr. F. 316 /ASTM-A-479 Gr. 316 or Integral with body

(3) Cast Iron Valves

Body & bonnet	IS-210 Gr. FG 260
Seating surfaces and rings	13% chromium steel/13% Chrome overlay
Disc for non-return valves	IS-210 Gr FG 260
Hinge pin for NRV	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/Eq.
Trim	IS 318 Gr. 2/Eq.

(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.

27.22 **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 260, 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.

27.23 **Painting Of Valves**

Two (2) coats of primer followed by two (2) 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 minimum 150 microns. 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.

27.24 **Rubber Expansion Joints**

27.24.1 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.

27.24.2 The expansion joints shall be single bellow rubber expansion joints. The arches of the expansion joints shall be filled with soft rubber.

27.24.3 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 60^0 A for outer and 50^0 A for inner cover.

27.24.4 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.

27.24.5 Reinforcement, consisting of solid metal rings embedded in carcass shall be provided.

27.24.6 Expansion joints shall be complete with stretcher bolt assembly. Expansion joints shall be suitable to absorb piping movements and accommodate mismatch between pipelines.

27.24.7 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.

27.24.8 The expansion joints shall be adequately reinforced, with solid steel rings, to meet the service conditions under which they are to operate.

27.24.9 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.

27.24.10 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.

27.24.11 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.

27.24.12 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.

27.24.13 Each joint shall have a permanently attached brass or stainless steel metal tag indicating the tag numbers and other salient design features.

27.24.14 Bidder to note that any metallic part which comes in contact with DM/ Corrosive water shall be of stainless steel material.

27.25 Strainers

27.25.1 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 NB (For DM water/ -Body: AISI 316 or equivalent)
(b)	Strainer Element	Stainless steel (AISI 316)
(c)	End connection	Screwed upto 50 NB, and flanged above 50NB

27.25.2 **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 NB, and IS: 210, Gr. FG 260 of ASTM-A-515 Gr. 75/IS-2062 Gr. B and internally epoxy-painted for 65 NB and above.
Strainer element	Stainless steel (AISI 316).
End connection	Screwed up to 50 NB; flanged for 65 NB & above. Gasket shall be of full face type.

(c) The strainer shall 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.

27.25.3 Two 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 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.

S. 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

3.00.00 **Ductile Iron Pipes**

3.01.01 Design Requirements: Pipeline shall be sized considering C value as 140 and velocity 2-3 M/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.

4.00.00 **Di Fittings & Specials**

4.01.00 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 Dl 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 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. 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 manufacturer has already conducted such specified type test(s), he may submit the type test reports during detailed engineering for consideration of waiver of conductance of such type test(s) or otherwise. 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 **Type Tests**

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 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.

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**

7.01.00 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.

7.02.00 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.

7.03.00 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.

DATA SHEET

S. 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

Sub : Sub-Qualifying Requirements for the Ventilation System

In line with the Sub-Qualifying Requirements stipulated in clause no. 4.4.7 of Chapter 04, "Provenness" , Volume II of Technical Specification of Bidding Documents, we have designed, supplied, erected and commissioned atleast two (2) numbers ventilations systems including air washer units having individual fan capacity of 1,25,000 M^3/hr. or more at each ventilation system, in industrial/Commercial installations. The systems should have been in successful operation for atteast two (2) years as on the date of Techno-commercial bid opening.

Sl.	Item	Plant 1	Plant 2
1.	Name of the Project and its address	.....	.....
2.	Name of the Client with address, name of Contact person(s) with tel.no. & fax no.	.....	.....
3.	Order No. and date		
4.	Purchase order enclosed	Yes*/No*	Yes*/No*
5.	Date of commissioning	.....	.....
6.	Individual fan capacity of air washer unit in ventilation system, M^3/hr.	.....	.....
7.	The scope for the ventilation system contract included		
	(a) Engineering	Yes*/No*	Yes*/No*
	(b) Supply	Yes*/No*	Yes*/No*
	(c) Erection	Yes*/No*	Yes*/No*
	(d) Commissioning	Yes*/No*	Yes*/No*

Sl.	Item	Plant 1	Plant 2
8.	No. of years of successful operation prior to date of techno-commercial bid opening	.....	.....
9.	The installation where the ventilation system has been provided can be treated as Industrial/commercial installation	Yes*/No*	Yes*/No*
10.	Documentary evidence with respect to item 5 to 8 above is enclosed	Yes*/No*	Yes*/No*
11.	Clients certificate regarding successful operation of ventilation system enclosed	Yes*/No*	Yes*/No*

Date :

Place :

(Signature).....

(Printed Name).....

(Designation).....

(Common seal).....

Note : Continuation sheets of like size and format may be used as per Sub-vendor's requirement and shall be annexed to this Attachment-3K.

SECTION: I

SUB-SECTION: C-3

TECHNICAL SPECIFICATION (ELECTRICAL PORTION)

SPECIFIC TECHNICAL REQUIREMENTS: ELECTRICAL

1.0 EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER/ PURCHASER

1.1 Scope for supply, erection and testing & commissioning of various equipment forming part of electrical system for this package shall be as per **Annexure-E.1** "SCOPE MATRIX BETWEEN BHEL AND VENDOR (FOR EPC PROJECTS)".

1.2 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 bidder without any extra charge shall provide the same.

1.3 Supply of mandatory spares as specified in the specifications of mechanical equipments.

1.4 Make of all electrical equipment/ items supplied shall be reputed make. Same shall be subject to approval of BHEL/customer after award of contract without any commercial & time implications. Tentative make list of various Electrical items is attached.

1.5 All QPs shall be subject to approval of BHEL/customer after award of contract without any commercial implication.

1.6 Various drawings including GA drg, data sheet as per required format, quality plans, calculations, test reports, test certificates, operation and maintenance manuals, characteristic curves, wiring diagrams/schemes etc. shall be furnished as specified at contract stage. All documents shall be subject to customer / BHEL approval without any commercial implications to BHEL.

1.7 Motors shall meet minimum requirement of Electric motor specification.

1.8 Vendor to clearly indicate equipment locations and local routing lengths in their cable listing furnished to BHEL.

1.9 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.

1.10 All Structural steel required for electrical equipment supplied by Vendor- as per scope split, shall be in Vendor's scope.

1.11 In the event of conflict between requirements of any two clauses of the specification/datasheet, the more stringent requirement shall prevail.

2.0 DOCUMENTS TO BE SUBMITTED ALONG WITH BID

2.1 Bidder shall confirm total compliance to the electrical specification without any deviation from the technical/ quality assurance requirements stipulated.

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.

3.0 LIST OF ENCLOSURES

1. Electrical scope Matrix between BHEL & vendor (Annexure-E.1).
2. Technical Datasheet of LT Motor (Annexure-E.2)
3. Motor Technical specification, Quality Plan & Sub-vendor list (Annexure-E.3)
4. Technical specification of miscellaneous items (Annexure-E.4)
5. Load data format (Annexure-E.5).
6. BHEL cable listing format (Annexure-E.6)

ANNEXURE-E.1
SCOPE MATRIX BETWEEN BHEL AND VENTILATION SYSTEM VENDOR (EPC PROJECTS)
PACKAGE: VENTILATION SYSTEM
PROJECT: 1 X 800 MW YAMUNANAGAR TPS

S.NO	DETAILS	SCOPE OF SUPPLY	SCOPE OF ERECTION	SCOPE OF TESTING & COMMISSIOINING	REMARKS
1	a) 415V ACDB / MCC	BHEL	BHEL	BHEL	415 V AC 3 phase, 3 wire supply (Normal and Emergency) 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/ Single phase AC) required will be derived by the vendor. For UPS (1Phase 230V AC) Power supply, C&I specification/ scope to be referred
2	Local Push Button Station (for motors)	BHEL	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	 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. Cabling/termination at BHEL equipment by BHEL and at Vendor equipment by Vendor.
4	Junction box for control & instrumentation cable	Vendor	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, fibre optical etc.	Vendor	Vendor	Vendor	Refer scope/ C&I portion of specification for scope of fibre Optical cables if used between PLC/ microprocessor & DCS.
6	Cable trays, accessories & cable tray support system	BHEL	BHEL	BHEL	
7	Cable glands, lugs and bimetallic washers for equipment supplied by Vendor	Vendor	Vendor	Vendor	1. Double compression Ni-Cr plated brass cable glands 2. Solder less crimping type heavy duty copper lugs for power & control cables.
8	Galvanised Steel Conduit and conduit accessories, 50/100 mm Galvanised Steel cable Troughs for local cabling between equipment supplied by vendor	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	BHEL	

ANNEXURE-E.1
SCOPE MATRIX BETWEEN BHEL AND VENTILATION SYSTEM VENDOR (EPC PROJECTS)
PACKAGE: VENTILATION SYSTEM
PROJECT: 1 X 800 MW YAMUNANAGAR TPS

S.NO	DETAILS	SCOPE OF SUPPLY	SCOPE OF ERECTION	SCOPE OF TESTING & COMMISSIOINING	REMARKS
10	Equipment grounding (Including Electronic earthing) & lightning protection	BHEL	BHEL	BHEL	Vendor shall indicate location of Electronic Earth pit in their Civil assignment drawing
11	Below grade grounding	BHEL	BHEL	BHEL	
12	LT Motors with base plate and foundation hardware	Vendor	Vendor	Vendor	Makes shall be subject to customer/ BHEL approval at contract stage.
13	Mandatory spares	Vendor	-	-	Vendor to quote as per specification.
14	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	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 in enclosed excel format shall be submitted by vendor during detailed engineering stage.
17	Equipment layout drawings	Vendor		-	For preparation of cabling layout drawings by BHEL, vendor shall furnish Electrical equipment 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,
18	Electrical Equipment GA drawing	Vendor		-	For necessary interface review.

NOTES:

1. Make of all electrical equipment/ items supplied shall be reputed make & shall be subject to approval of BHEL/customer after award of contract.
2. All QPs shall be subject to approval of BHEL/customer after award of contract without any commercial implication.
3. In case the requirement of Junction Box arises on account of Power Cable size mis-match due to vendor engineering at later stage, vendor shall supply the Junction Box for suitable termination.

B-02 (LT MOTORS TECHNICAL DATA)

SL.NO	DESCRIPTION	UOM	DETAIL
1.0	**DESIGN CODES & STANDARDS**		
1.1	Three phase induction motors :		IS15999, IEC:60034, IS: 12615, IS: 325
1.2	Energy Efficient motors		IS 12615, IEC:60034-30
1.3	Mechanical Vibration of Rotating Electrical Machines with Shaft Heights 56 mm and Higher - Measurement, Evaluation and Limits of Vibration Severity		IS 12075/IEC 60034-14
1.4	Designation of Methods of Cooling of Rotating Electrical Machines		IS 6362
1.5	Designation for types of construction and mounting arrangement of rotating electrical machines		IS 2253
2.0	**DESIGN /SYSTEM PARAMETERS**		
2.1	Rated voltage	V	415
2.2	Frequency	Hz	50
2.3	Permissible variations for		
a)	Voltage	%	+/-10
b)	Frequency	%	(+)5 to (-)5
c)	Combined	%	10 (absolute sum)
2.4	System fault level at rated voltage for 1 sec	kA	50
2.5	Short time rating for terminal boxes for 0.25 sec	kA	50
2.6	Type of motors		Squirrel cage induction motor
a)	Non-VFD		Suitable for direct on line starting
b)	VFD (if applicable)		Suitable for inverter duty
2.7	Efficiency class		
a)	Output rating (at 50 deg.C ambient temperature)		Efficiency class
i)	upto 50 KW		Premium Efficiency Class-IE3
ii)	50- 160 KW		Premium Efficiency Class-IE3
2.8	Rating		
a)	Motor duty		Continuously rated-S1
b)	Design margin over continous max. demand of the driven equipment (minimum) (If however, a higher margin is stipulated in the accompanying driven equipment specification, the higher stipulated margin shall prevail).		10%
3.0	**CONSTRUCTION FEATURES**		
3.1	Winding		Electrolytic grade copper conductor
3.2	Enclosure Details		
a)	Degree of protection		
	i) Indoor application		IP 55
	ii) Outdoor application		IP 55 (Additional Canopy to be provided)
b)	Method of ventilation		Totally enclosed fan cooled (TEFC) type
3.3	Insulation		
a)	Class		'F' with temperature rise limited to 70 Deg. C
b)	General Characteristics		Non-hygroscopic, oil resistant, flame resistant
c)	Special Characteristics		VPI insulation for VFD motors
3.4	Main terminal box		
a)	Type		Detachable type
b)	Location		In accordance with Indian Standards clearing the motor base- plate/ foundation
c)	Terminals		Stud or lead wire type, substantially constructed and thoroughly insulated from the frame
d)	Markings		Phase markings on terminals and direction of rotation marked on the non-driving end
e)	DOP		Same as motor

f)	Rotation		360 Deg. rotatable in stepts of 90 Deg.
g)	Space heater (for ratings 30 kW and above)		Suitable for 240V, 50Hz 1 ph AC. Separate terminal box provided for space heaters.
h)	Cable glands/lugs/gland plates		
i)	Size		As per cable size used
ii)	Lugs		Solderless crimpting type heavy duty copper lugs
iii)	Glands		Double compression Ni-Cr plated brass glands
iv)	Gland plate thickness		3 mm (hot/cold rolled sheet steel) or 4 mm (non magnetic material for single core cables)
3.5	Earthing points		
a)	No. of points on motor body		Two earthing points on opposite sides with two separate and distinct grounding pads complete with tapped holes, GI bolts and washers.
b)	No. of points on motor terminal box		One earthing point complete with tapped holes, GI bolts and washers.
c)	Earthing Flat size (Indicative)		Motor Earthing Terminal will be suitable for termination of Earthing Flat size (tentative) indicated below. Final size will be confirmed by BHEL during contract stage.
i)	LT Motors above 125 KW		50 x 6mm GS flat
ii)	25 KW to 125 KW		25 x 6mm GS flat
iii)	1KW to 25 KW		25 x 3mm GS flat
iv)	Fractional kW		8 SWG GS Wire
3.6	Painting		Corrosion proof epoxy based paint with suitable additives to be used.
a)	Paint shade		Paint shade shall be informed by BHEL during contract stage
b)	Thickness of paint		The thickness of finish coat shall be minimum 50 microns (minimum total DFT 100 microns).
3.7	Minimum spacing between gland plate & centre of bottom terminal stud		
a)	UP to 3 KW		As per manufacturer's practice.
b)	Above 3 KW - upto 7 KW		85 mm
c)	Above 7 KW - upto 13 KW		115 mm
d)	Above 13 KW - upto 24 KW		167 mm
e)	Above 24 KW - upto 37 KW		196 mm
f)	Above 37 KW - upto 55 KW		249 mm
g)	Above 55 KW - upto 90 KW		277 mm
h)	Above 90 KW - upto 125 KW		331 mm
i)	Above 125 KW-upto 200 KW		385/203 (For Single core cables only) mm
3.8	Minimum inter-phase and phase-earth air clearances with lugs installed		
a)	UP to 110 KW		10mm
b)	Above 110 KW and upto 150 KW		12.5mm
c)	Above 150 KW		19mm
4.0	**PERFORMANCE PARAMETERS**		
4.1	Starting requirement		
a)	Minimum permissible voltage as a percentage of rated voltage, at start to bring the driven equipment upto rated speed		Up to 80% of rated voltage
b)	Maximum locked rotor current		As per IS 12615
c)	Starting duty (Cold/ Hot Motor Starting)		Refer techncial specification of motor clause no. 16.13.00 (STARTING CAPABILITY) (Annexure E.3)
d)	The locked rotor withstand time		Speed switches mounted on the motor shaft shall be provided in cases where below requirements are not met.
e)	Starting time of motors at minimum permissible voltage during starting		The locked rotor withstand time under hot condition at highest voltage limit
i)	upto 20 secs.		atleast 2.5 secs. more than starting time
ii)	more than 20 secs. and upto 45 secs		atleast 5 secs. more than starting time

iii)	more than 45 secs.		more than starting time by at least 10% of the starting time
4.2	Torque		
a)	Accelerating torque at any speed with the lowest permissible starting voltage		at least 10% motor full load torque
b)	Pull out torque at rated voltage		at least 205% of full load torque
4.3	Noise level (max.)		85 dB(A) at 1m from motor
4.4	Vibration limits		As per IS 12075/ IEC 60034-14.
5.0	**INSPECTION/TESTING**		
5.1	Type testing requirement w.r.t submission of reports and conduction of type tests		Refer techncial specification of motor clause no. 16.47.02 (TESTS- LT Motors).
5.2	Project specific type test report validity period is as mentioned. *(In absence of type tests reports or in case reports are not found to be meeting the specification/standards requirements, validity period, vendor shall conduct all such type tests without any commercial/delivery implication to BHEL and reports shall be submitted to the owner for approval.)*		Within 5 years prior to 25.03.25.
5.3	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.		
5.4	Quality plan attached with the technical specification (Annexure-E.3) is to be followed.		

	1X800MW HPGCL YAMUNANAGAR TPS TECHNICAL SPECIFICATION FOR VENTILATION SYSTEM (ELECTRICAL PORTION) (LT MOTORS TECHNICAL DATA SHEET) (SUPPLIER DATA TO BE FURNISHED AFTER AWARD OF CONTRACT)	Specification No. Issue No: 01 Rev. No. 00 Date : 15.07.2026

B-02 (TECHNICAL DATA - PART-B(SUPPLIER DATA TO BE FURNISHED AFTER AWARD OF CONTRACT)

SL.NO		UOM	DETAIL
1.0	**GENERAL**		
i)	Manufacturer & Country of origin.		
ii)	Equipment driven by motor)		
iii)	Motor type		
iv)	Country of origin		
v)	Quantity	nos.	
2.0	**DESIGN AND PERFORMANCE DATA**		
i)	Frame size		
ii)	Type of duty		
iii)	Type of enclosure and method of cooling		
vi)	Type of mounting		
vii)	Direction of rotation as viewed from DE END		
viii)	Standard continuous rating at 40 deg.C. ambient temp. as per Indian Standard	(KW)	
ix)	(A) Derated rating for specified normal condition i.e. 50 deg. C ambient temperature	(KW)	
	(B) Rating as specified in load list	(KW)	
xi)	Rated speed at rated voltage and frequency	rpm	
xii)	At rated Voltage and frequency		
	a) Full load current	A	
	b) No load current	A	
xiii)	Power Factor at		
	a) 100% load		
	b) At duty point		
	c) 75% load		
	d) 50% load		
	e) NO load		
	f) Starting.		
xiv)	Efficiency at rated voltage and frequrecy		
	a) 100% load		
	b) At duty point		
	c) 75% load		
	d) 50% load		
xv)	Starting current*(inclusive of IS tolerance)* at		
	a. 100 % voltage	A	
	b. Minimum starting voltage	A	
xvi)	Starting time with minimum permissible voltage		
	a. Without driven equipment coupled	sec	
	b. With driven equipment coupled	sec	
xvii)	Safe stall time with 110% of rated voltage		
	a. From hot condition	sec	

	b. From cold condition	sec	
xviii)	**Torques :**		
	a. Starting torque at min. permissible voltage	(kg-mtr.)	
	b. Pull up torque at rated voltage.	(kg-mtr.)	
	c. Pull out torque	(kg-mtr.)	
	d. Min accelerating torque available	(kg-mtr.)	
	e. Rated torque	(kg-mtr.)	
xix)	Stator winding resistance per phase (at 20 Deg.C.)	Ohm	
xx)	GD^2 value of motors		
xxi)	Locked rotor KVA input (at rated voltage)		
xxii)	Locked rotor KVA/KW.		
xxiii)	**Bearings**		
	a. Type		
	b. Manufacturer		
	c. Self Lubricated or forced Lubricated		
	d. Recommended Lubricants		
	e. Guaranteed Life in Hours		
	f. Whether Dial Type thermometer provided		
	g. Oil pressure Gauge/switch		
	i. Range		
	ii. Contact Nos. & ratings		
	iii. Accuracy		
xxiv)	**Vibration**		
	a) Velocity	mm/s	
	b) Displacement	microns	
xxv)	Noise level	db	
3	**CONSTRUCTIONAL FEATURES**		
i	Stator winding insulation		
	a. Class & Type		
	b. Tropicalised (Yes/No)		
	c. Temperature rise over specified max.		
	i. Cold water temperature of 38 DEG. C.		
	ii. Ambient Air 50 DEG. C.		
	d. Method of temperature measurement		
	e. Stator winding connection		
	f. Number of terminals brought out		
ii	Type of terminal box for		
	a. stator leads		
	b. space heater		
	c. Temperature detectors		
	d. Instrument switch etc.		
iii)	For main terminal box		
	a. Location		
	b. Entry of cables		
	c. Recommended cable size		

	d. Fault level	MVA	
iv)	Temperature detector for stator winding		
	a Type		
	b. Nos. provided		
	c . Location		
	d. Make		
	e. Resistance value at 0 deg. C	ohms	
vi)	Paint shade		
vii).	Weight of(approx)		
	a. Motor stator (KG)		
	b. Motor Rotor (KG)		
	c. Total weight (KG)		
4	Relevant motor curves		

Annexure-E.3

Motor Technical specification, Quality Plan & Sub-vendor list

CHAPTER – 16

AC & DC MOTORS

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CHAPTER – 16

AC & DC MOTORS

16.01.00 **SCOPE**

This chapter covers 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.

16.01.01 Site Conditions

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

16.01.02 Gases, Fumes & Dust Particles

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

16.01.03 Dust Particles

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

ii) Indoor Locations.

iii) Coal conveyors - As for outdoor as per clause 16.01.03 (i) above.

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

16.01.04 Special Fumes

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

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

iii) For the purpose of design of equipment/systems, an ambient temperature of 50^0C and relative humidity of 95% (at 40^0C) shall be considered. The equipment shall operate in a highly polluted environment.

16.02.00 **LOCATION OF MOTORS -** As required

16.03.00 **CODES AND STANDARDS**

All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) / IEC as mentioned in Chapter 37 except where modified and/or supplemented by this specification.

Equipment and material conforming to any other standard, which ensures equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted shall be furnished during detail engineering.

The electrical installation shall meet the requirements of Indian Electricity Rules as amended up to date and relevant IS Code of Practice. In addition, other rules and regulations applicable to the work shall be followed.

16.04.00 **TYPE**

16.04.01 AC Motors:

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

ii) Continuous duty LT motors rated above 0.37kW up to 160 KW Output rating (at 50^0 C ambient temperature), shall be **Efficiency class-IE3**, conforming to IS 12615, or IEC:60034-30. However, this is not applicable for geared motors (motors completely integrated with driven equipment) which are specifically designed to suit the driven equipment duty.

iii) Crane, hoist & elevator duty motors shall be squirrel cage Induction motor of S4 duty and 40% CDF or VFD motors.

16.04.02 DC Motors

i. D.C. motor provided for emergency service shall be shunt wound type. It can also be of compound-wound type with the series field shorted.

ii. Motor shall be sized for operation with fixed resistance starter for maximum reliability. Starter panel complete with all accessories shall be included in the scope of supply.

16.04.03 VFD Motors

i. Induction motors to be operated in adjustable-speed drive applications should be derated as per NEMA/IEC standard due to the reduction in cooling resulting from any reduction in operating speed and the effect of additional losses introduced by harmonics generated by the control.

ii. Inverter duty motors shall be self-ventilated without any auxiliary blower. Force ventilation shall be subject to Owner approval.

iii. Inverter duty motors shall have VPI insulation systems that do not degrade readily due to transient voltage spikes and have an adequate thermal margin.

iv. Inverter duty motors are designed according to the requirements of IEC 60034 Part-17 & Part-25 or NEMA MG-1, Part-30, Part-31 and have performance characteristics match with the driven equipment and variable speed requirement.

v. The motor should be capable of producing a breakaway torque of at least 140% of rated torque requiring not more than 150% rated current when the voltage boost is adjusted to develop rated flux in the motor and when the inverter is able to produce the required minimum fundamental frequencies.

vi. The breakdown torque at any frequency within the defined frequency range shall be not less than 150% of the rated torque at that frequency when rated voltage for that frequency is applied.

vii. The motor shall be provided with insulated bearing on one side.

viii. Normally the maximum safe speed shall be as per IEC/NEMA, however it should be coordinated with VFD requirement.

16.05.00 **VOLTAGE (NOMINAL)**

16.05.01 LV Motors

For motors up to and including 160 KW - Four hundred fifteen (415) V.

16.05.02 MV Motors

For motors above 160 kW up to and including 1500kW - Six-point six (6.6) kV.

16.05.03 HV Motors

i) For motors above 1500kW - eleven (11) KV
ii) All motors are to be designed for system grounding described in "System Particulars" under site information of the Driven Equipment Specification.

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

16.07.00 **NUMBER OF PHASES** - Three (3)

16.08.00 **SPEED** - As required by the driven equipment

16.09.00 **TYPE OF STARTING** - Direct on-line

16.10.00 **DUTY**

16.10.01 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. If however, a higher margin is stipulated in the accompanying driven equipment specification, the higher stipulated margin shall prevail.

16.10.02 Motor rating shall be such that it is not overloaded at any operating point of driven equipment from zero to full load.

16.10.03 The break-away torque, pull-up torque and pull-out torque of the motors shall be properly coordinated with the requirements of driven equipment to ensure smooth and rapid starting and steady operation. The torque-speed characteristic of motor super imposed thereon on driven equipment torque-speed characteristics at 100%, 90%, 80% shall be furnished.

16.10.04 All HV & MV motors shall be provided with vibration pads for mounting vibration detectors.

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

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

16.10.07 HV & MV motors shall have full load efficiency of 95% minimum and rated full load power factor of 0.8 minimum. The required power factor shall be achieved without using external capacitor. Tolerance on this efficiency value shall be applicable as per IEC 60034. However, this is not applicable for geared motors (motors completely integrated with driven equipment) which are specifically designed to suit the driven equipment duty.

16.11.00 **SUPPLY VARIATIONS .....** Motors shall be capable of running continuously at full load under following variations in power supply.

16.11.01 Voltage (percent of nominal voltage) ..... Plus minus (±) ten (10) for LT
Plus minus (±) Six (6) for MV & HT

16.11.02 Frequency (percent of minimal frequency) ..... Plus Three 3 & minus (-) five (5)

16.11.03 Combined voltage & frequency (percent) ..... Ten (10) (sum of absolute percentage value of voltage and frequency variation)

16.12.00 **ABNORMAL CONDITIONS CAPABILITY**

Motor shall have following capabilities as specified design ambient temperature:-

16.12.01 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.

16.12.02 Pump motor subject to reverse rotation shall be designed to withstand the stresses encountered when starting with non-energized shaft rotating at 125% rated speed in reverse direction.

16.12.03 Low Voltage Running: -

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

16.12.04 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.

16.13.00 **STARTING CAPABILITY**

16.13.01 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%.

16.13.02 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 shall be made till lapse of further thirty (30) minutes. (With initial temperature of the motor at ambient temperature)

16.13.03 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 shall be made till lapse of further thirty (30) minutes. (With initial temperature of the motor at full load operating level)

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

16.13.05 Break-away Starting Current

Breakaway starting current as percent of full load current for various motor ratings shall not exceed the values given below:-

i) -DELETED-

ii) Motors (above 1000 KW up to 3000 KW)..... 600%. Subject to 20% IS tolerance.

iii) Motors above 3000 KW.....450%. Not subject to any positive tolerance. For energy efficient

iv) LT motors, locked rotor current shall be as per IS: 12615.

v) Locked rotor current of the VFD controlled AC motors shall be limited to 300% of the full load current, and is subject to IS tolerance

16.13.06 Where variable voltage and variable frequency (VVFD) operation is envisaged through VVFD drives, motors shall be specially designed for such application.

16.14.00 **STARTING VOLTAGE REQUIREMENT**

16.14.01 All Motors (except Mill Motors)
i) 80% of rated voltage for Motors up to 4000 kW
ii) 75% of rated voltage for Motors above 4000 kW

16.14.02 For Mill Motors:

i) 85% of rated voltage for Motors above 1000 kW
ii) 90% of rated voltage for Motors below 1000 kW

16.15.00 **TORQUE REQUIREMENTS**

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

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

16.16.00 **STARTING TIME**

16.16.01 For motors with starting time up-to 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.

16.16.02 For motors with starting time more than 20 secs. and up-to 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.

16.16.03 For motors with starting time more than 45 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be more than starting time by at-least 10% of the starting time.

16.16.04 At no stage, speed switch shall be provided to achieve requirements mentioned in Clause No. 16.16.01 to 16.16.03.

16.17.00 **CLASS OF INSULATION**

16.17.01 LV Motors ..... Class F.

16.17.02 HV & MV Motors ..... Class F

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

16.17.04 The value of the polarization index for motors above 160kW should not be less than 2 when determined according to IS: 78114.0

16.17.05 For the VFD operated drives, insulation shall be designed to take care of stresses due to high DV/DT. Motors shall be wound with dual coated winding wires and impregnated with VPI process. Further for such application, insulated bearings shall be provided to avoid circulating current caused by shaft induced voltages,

16.17.06 HT motors shall withstand 1.2/50 micro sec impulse Voltage wave of 4U+5 kV (U=Line voltage in kV). The coil inter-turn insulation shall be as per IEC-60034 – Part 15 followed by 1 min power frequency high voltage test of appropriate voltage on inter turn insulation.

16.18.00 **TEMPERATURE RISE UNDER NORMAL CONDITIONS**

16.18.01 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
i)	50^0C	60^0C	70^0C

16.18.02 For Water Cooled Motors, temperature rise of insulation should be limited to 80 deg. C, over inlet cooling water temperature mentioned elsewhere, by resistance method.

16.19.00 **BUS TRANSFER WITHSTAND CAPABILITY**

Motors shall 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.

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

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

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

16.20.00 **TYPE OF ENCLOSURE**

16.20.01 Outdoor Motors……. IP 55 (Additional canopy to be provided by Bidder).

16.20.02 Indoor Motors ..... IP 55

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

16.21.00 **METHOD OF COOLING**

16.21.01 Method of cooling shall be either totally enclosed fan cooled (TEFC) or totally enclosed tube ventilated (TETV) or Closed air circuit air cooled (CACA) type. However, motors rated 3000KW or above can be Closed air circuit water cooled (CACW).

The method of movement of primary and secondary coolant shall be self-circulated by fan or pump directly mounted on the rotor of the main motor as per IEC 60034-6. However, VFD driven motors can be offered with forced cooling type with machine mounted fan or pump driven by separate electric motor.

Motors and EPB located in hazardous areas shall have flame proof enclosures conforming to IS:2148 as detailed below

(a) Fuel oil area: Group – IIB

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

16.21.02 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.

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

16.23.00 **MAXIMUM MECHANICAL VIBRATIONS**

Vibration shall be limited within the limits prescribed in IS: 12075 / IEC 60034-14. Motors shall withstand vibrations produced by driven equipment. HV & MV motor bearing housings shall have flat surfaces, in both X and Y directions, suitable for mounting 80mmX80mm vibration pads. Vibration pads with screwed holes along with vibration probes shall be provided at both DE and NDE.

16.24.00 **NOISE LEVEL**

16.24.01 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). at 1m from operating motor measured in accordance with IS: 10265.

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

16.24.03 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 - up to 7 KW	85
Above 7 KW - up to 13 KW	115
Above 13 KW - up to 24 KW	167
Above 24 KW - up to 37 KW	196
Above 37 KW - up to 55 KW	249
Above 55 KW - up to 90 KW	277
Above 90 KW - up to 125 KW	331
Above 125 KW-up to 160 KW	203

16.24.04 For HV & MV motors the distance between gland plate and the terminal studs shall not be less than 500 mm.

16.24.05 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.

16.24.06 For motors rated 1000 KW & above, neutral current transformers of PS class shall be provided on each phase in a separate neutral terminal box.

16.25.00 **WINDING & INSULATION**

16.25.01	Type	:	Non-hygroscopic, oil resistant, flame resistant
16.25.02	11kV & 6.6 kV AC motors	:	Thermal class 155 (F) insulation and the temperature rise shall be limited to Class B. Winding material shall be F/B class electrolytic copper grade polymica insulated rectangular bar type copper conductor. The winding insulation process shall be total Vacuum Pressure Impregnated i.e resin poor method. The lightning Impulse & inter-turn insulation surge withstand level shall be as per IEC-60034 part-15
16.25.03	240VAC, 415V AC & 220V DC motors	:	Thermal Class(F)

16.26.00 **DIRECTION OF ROTATION**

16.26.01 As needed by driven equipment.

16.26.02 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.

16.26.03 If, in the case of HV & MV 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.

16.27.00 **BEARINGS**

16.27.01 Greased ball, roller and/or sleeve bearing shall be rated for minimum standard life of 40000 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.

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

16.27.03 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.

16.27.04 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.

16.27.05 For MV & HV motors rated 1000KW and above , the bearing housing shall be insulated wherever necessary to prevent damage to motor bearings from shaft current.

16.27.06 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.

16.27.07 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.

16.27.08 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.

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

16.27.10 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.

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

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

16.30.00 **LIFTING DEVICES** ..... Motors shall be provided with eye-bolts, lugs or other means to facilitate safe lifting.

16.31.00 **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).

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

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

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

16.34.01 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.

16.34.02 Temperature rise under normal/abnormal conditions.

16.34.03 Type of bearing and recommended lubricants.

16.35.00 **FINISH**

16.35.01 Motor shall have synthetic enamel paint shade as mentioned in Chapter 1.

16.35.02 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.

16.36.00 **TERMINAL BOXES**

16.36.01 General

i) Motors shall be provided with separate terminal boxes for main, space heaters, embedded temperature detectors, bearing temperature indicators and moisture detectors terminals, Neutral CT 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 cable to be finalized during detailed engineering.

ii) 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 HV & MV motors shall be provided with phase segregated terminal box as per Cl 16.36.02 (ii).

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

16.36.02 Main Terminal Box

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

ii) MV & HV Motors 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. For motors rated below 1000 KW should be interchangeable to facilitate cable routing. Alternately if elastimould terminations are offered, then protective cover and trifurcating sleeves shall also be provided.

iii) Neutral terminal box for MV/HV motors rated 1000 KW and above shall be suitable for mounting of three (3) Nos. wound/bar primary/ring type cast resin insulated current transformers for differential protection. These CTs shall be mounted in the motor neutral terminal box. Stator phase terminal box shall be phase segregated terminal box suitable for both top or 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 terminating Kit. Terminal leading shall be stud type or leading wire type.

iv) Terminal Boxes shall be provided with cable end boxes having cable lugs and cable glands for cables. For 11/6.6kV motors 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 in case of cable boxes.

v) The terminal boxes shall be capable of withstanding at the terminals the system fault level (as mentioned in Data Sheet) without rupture for a duration of at least 0.25 seconds.

vi) Phase to Phase/ Phase to Earth Air Clearance: -

a) 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

vii) 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.

16.37.00 **TYPE AND SIZE OF CABLES**

16.37.01 Space Heaters

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

ii) For MV & HV Motors: Two-point five (2.5) sqmm two core copper conductor XLPE insulated armoured and FRLS PVC sheathed heavy duty 650/1100V grade cable to IS: 1554 (Part-I). For higher rating HV/MV motors 3 phase space heater shall be used and cable size shall be 3Cx6 sqmm copper.

iii) 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).

iv) 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.

v) For Moisture Detectors.....As for space heaters as per Clause 16.37.01 (i) above.

16.37.02 For Main Terminals: -

i) LT Motors

a) Three (3) core cables .....Stranded aluminium conductor, XLPE insulated, colour coded, laid up, FRLS PVC type ST2 sheathed, GI wire / strip armoured, FRLS PVC type-ST2 jacketed overall, 650 / 1100V grade, heavy-duty cables as per IS: 1554 (Part-I).

b) Single core cables .....Stranded aluminium conductor, XLPE insulated, hard drawn aluminium wire/ strip armoured FRLS PVC type ST2 jacketed overall, 1100V grade, heavy duty cable as per IS: 1554 (Part-I).

ii) HV & MV Motors

Three (3) core cables ..... stranded aluminium conductor, XLPE insulated, screened colour coded, laid up, FRLS PVC type ST2 sheathed, GI wire/strip armoured FRLS PVC type ST2 jacketed overall, 6.6 KV / 11 KV unearthed grade, heavy duty cables as per requirement for unearthed system as per IS: 7098 (Part-II).

16.38.00 **GROUNDING**

16.38.01 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.

16.38.02 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 up to 5.5 KW) for size of conductor specified shall be provided.

16.38.03 HV & MV 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.

16.39.00 **EMBEDDED TEMPERATURE DETECTORS**

HV & MV motor shall be provided with four (4) Nos. simplex or two (2) Nos. duplex platinum resistance temperature detectors (RTDs) in each phase embedded in stator winding at locations where high temperatures are expected. In addition, one (1) duplex type RTD shall be provided in each bearing. However, for air compressor, being high speed drive, each motor bearing shall be provided with minimum two numbers of duplex RTDs connected to two numbers of dual input transmitters with display unit. The RTDs shall be 3 wire duplex platinum resistance type having a value of 100 ohms at 0 Deg C.

16.40.00 **BEARINGS TEMPERATURE INDICATORS**

HV & MV motors shall be provided with dial type two (2) bearing temperature indicators and shall 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 shall be set to

operate at lower value to give alarm and other set at a higher value to trip the motor.

16.41.00 **SPACE HEATERS**

16.41.01 Valve / Damper actuator motors; and Motors 30 KW and above 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.

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

16.41.03 The space heater shall be wired to maintain the motor internal temperature above dew point when the motor is in idle condition.

16.42.00 **HOT AIR TEMPERATURE DETECTOR**

If the motor is of CACA or CACW enclosure, dial type temperature indicator shall be provided (one each for hot and cold air temperature monitoring for CACA and CACW and one each for inlet and outlet water temperature monitoring for CACW). In addition, one (1) duplex type RTD shall be provided in each enclosure for alarm and if trip is required for cooling air temperature, temperature switch shall be provided.

16.43.00 **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. In addition, one (1) duplex type RTD shall be provided in each water inlet and outlet circuit

16.44.00 **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.

16.45.00 **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.

16.46.00 **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.

16.47.00 **TESTS**

16.47.01 HV & MV Motors

i) Routine Tests

All equipment shall be completely assembled, wired, adjusted and all acceptance and routine tests as per the specification and relevant standards shall be carried out. These tests shall be carried out in presence of the Owner's representative, for which a minimum 7 days' notice shall be given by the Bidder. Charges for these shall be deemed to be included in the equipment price.

ii) Type Tests

a) For each type & rating of HV & MV motors the Bidder shall submit for Owner's approval the reports of all the type tests as per relevant standards. 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 conducted at an independent laboratory. Period - Within 5 Years from the zero date.

b) In case the Bidder is not able to submit report of the type test(s) conducted,, or in case the type test report(s) are not found to be meeting the specification requirements, the Bidder shall conduct all such tests under this contract free of cost to the Owner and submit the reports for approval, for which a minimum 7 days' notice shall be given by the Bidder. Charges for these shall be deemed to be included in the equipment price

iii) List of minimum type tests to be conducted

The following Minimum type tests shall be conducted on each type and rating of HV & MV motor:-

a) No load saturation and loss curve up to approximately 115% of rated voltage.

b) Measurement of noise at no load.

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

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

e) IR + PI

f) Partial Discharge

g) Winding resistance

h) 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 ETDs are provided, the temperature shall be measured by ETD's also for the record purpose. In case due to test bed limitations at the manufacturing works, mixed frequency method as per latest IEC 60034 is also acceptable.

i) Lightning Impulse withstand test on the sample coil shall be as per IEC-60034, part-15

j) Surge-withstand test on interturn insulation shall be as per IEC60034, part-15

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

l) Terminal box-fault level withstand test for each type of terminal box.

m) 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.

16.47.02 LT Motors

i) Routine Test

All equipment shall be completely assembled, wired, adjusted and routine tested as per relevant IS/IEC Standards at manufacturer's works in the presence of Consultant /Owner or his representative.

ii) List of minimum tests for which reports have to be submitted

The following minimum type test reports shall be submitted for each type and rating of LT motor of above 30 KW only

a) Measurement of resistance of windings of stator and wound rotor.
b) No load test at rated voltage to determine input current power and speed.
c) Open circuit voltage ratio of wound rotor motors (in case of Slip ring motors)
d) Full load test to determine efficiency power factor and slip.
e) Temperature rise test.
f) Momentary excess torque test.
g) High voltage test.
h) Test for vibration severity of motor.
i) Test for noise levels of motor(Shall be limited as per clause No. 1.24.00 of this section)
j) Test for degree of protection and
k) Over speed test.

l) Type test reports for motors located in fuel oil area having flame proof enclosures as per IS 2148 / IEC 60079-1

iii) 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.

16.48.00 **INFORMATION WITH PROPOSAL**

16.48.01 AC Motor Data Sheet.

16.48.02 Dimension Drawing/Foundation load details of motor and driven equipment.

16.48.03 Manufacturer's catalogue showing constructional details.

16.49.00 **INFORMATION ON AWARD OF CONTRACT**

16.49.01 Motor Data Sheet

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.

16.49.02 Following characteristics curves: -

i) 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 except for mill motor. For mill motor torque speed curve for motor at ninety (90) hundred (100) and hundred ten (110) percent rated voltage as well as torque-speed curve for driven equipment

ii) Current-speed curves at eight (80), hundred (100) and hundred ten (110) percent rated voltage except for mill motor. For mill motor current speed curve for motor at ninety (90) hundred (100) and hundred ten (110) percent rated voltage

iii) Current-time curves at eighty (80), hundred (100) and hundred ten (110) percent rated voltage except for mill motor. For mill motor current time curve for motor at ninety (90) hundred (100) and hundred ten (110) percent rated voltage.

iv) Thermal withstand curves for hot and cold at eighty (80), hundred (100) and hundred ten (110) percent rated voltage except for mill motor. For mill motor thermal withstand curve for motor at ninety (90) hundred (100) and hundred ten (110) percent rated voltage.

v) Efficiency, power factor, current and speed versus power output curves.

vi) Speed-time curves at eight (80), hundred (100) and hundred ten (110) percent rated voltage except for mill motor. For mill motor speed time curve for motor at ninety (90) hundred (100) and hundred ten (110) percent rated voltage.

vii) Negative phase sequence current withstand characteristics.

16.50.00 **DC MOTOR**

16.50.01 D.C. Motor provided for emergency service shall be shunt / compound would type. The starting current shall be as per manufacturer's standard.

16.50.02 Motor shall be sized for operation with fixed resistance starter for maximum reliability.

16.50.03 Starter panel complete with all accessories shall be included in the scope of supply.

16.51.00 **DRAWINGS, DATA & MANUALS**

16.51.01 Minimum Drawings, data & manuals for the motors to be submitted

i) Dimensional General Arrangement drawing
ii) Foundation Plan & Loading
iii) Cable end box details
iv) Space requirement for rotor removal
v) Thermal withstand curves hot & cold
vi) Starting and speed torque characteristics at 80% & 100% voltage except for mill motor. For mill motor Starting and speed torque characteristics at 90% & 100% voltage.
vii) Complete motor data
viii) Erection & Maintenance Manual
ix) Test reports
x) QAP

DATASHEET

	Auxiliary power supply	
1.1	**HV supply**	
	11kV, 3Φ, 3W, 50 Hz non effectively earthed Earthed through resistance, limiting earth fault current to 400 Amps	Motors rated above 1500 kW
	Fault level	50 kA for 1 second
	HV Motors	shall be controlled through vacuum circuit breaker
	The cooling tubes of Motor	Shall be of Stainless Steel
1.2	**MV supply**	
	6.6kV, 3Φ, 3W, 50 Hz non effectively earthed. Earthed through resistance, limiting earth fault current to 400 Amps	Motors above 160kW up to and including 1500kW
	Fault level	40 kA for 1 second
	MV Motors	shall be controlled through vacuum circuit breaker
	The cooling tubes of Motor	Shall be of Stainless Steel
1.3	**LV supply**	
	415V, 3Φ, 3W, 50 Hz effectively earthed	Motors below and including 160kW
	Fault level	50kA for 1 second
	110V, 1Φ, 2W, 50 Hz effectively earthed	Lighting, space heating, AC control and protective devices
	LT motors rated up to 90 kW	shall be controlled through MPCB/ MCCB and contactor.
	LT motors rated more than 90 kW	Shall be controlled through air circuit breaker
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.		

QUALTIY PLAN

MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:
	CUSTOMER :		QP NO.: PE-QP-999-Q-006, REV-02	DATE: 17.04.2020
	PROJECT:		PO NO.:	DATE:
	ITEM: AC ELECT. MOTORS UPTO 50 KW 415V	SYSTEM:	SECTION: II	SHEET 1 of 2

S. NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY				REMARKS
1	2	3	4	5	6		7	8	9	*	**			
					M	C/ N				D	M	C	N	
1.0	ASSEMBLY	1.WORKMANSHIP	MA	VISUAL	100%	-	MFG. SPEC.	MFG. SPEC.	LOG BOOK		P	-	-	
		2.DIMENSIONS	MA	VISUAL	100%	-	MFG. DRG./ MFG. SPEC.	MFG. DRG./ MFG. SPEC.	LOG BOOK		P	-	-	
		3.CORRECTNESS COMPLETENESS TERMINATIONS/ MARKING/ COLOUR CODE	MA	VISUAL	100%	-	MFG.SPEC./	MFG.SPEC.	LOG BOOK		P	-	-	
2.0	PAINTING	1.SHADE	MA	VISUAL	SAMPLE	-	MFG. SPEC/ APPROVED DATASHEET	MFG. SPEC/ APPROVED DATASHEET	LOG BOOK	✓	P	V	-	
3.0	TESTS	1.ROUTINE TEST INCLUDING SPECIAL TEST	MA	VISUAL	100%	-	IS-325 / IS-12615/ APPROVED DATA SHEET	IS-325 / IS-12615/ APPROVED DATA SHEET	TEST/ INSPN. REPORT	✓	P	V *	-	* NOTE -1
		2.OVERALL DIMENSIONS & ORIENTATION	MA	MEASUREMENT & VISUAL	100%	-	APPROVED DRG/ DATA SHEET	APPROVED DRG/ DATA SHEET	TEST/ INSPN. REPORT	✓	P	V *	-	* NOTE -1 & NOTE-2

BHEL						BIDDER/ SUPPLIER	
ENGINEERING			QUALITY			Sign & Date	
	Sign & Date	Name		Sign & Date	Name	Seal	
Prepared by:	HEMA KUSHWAHA	HEMA KUSHWAHA	Checked by:		KUNAL GANDHI		
Reviewed by:	PRAVEEN DUTTA	PRAVEEN DUTTA	Reviewed by:	RITESH KUMAR JAISWAL	RITESH KUMAR JAISWAL		

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

THIS IS PART OF TECHNICAL SPECIFICATION PE-TS-497-501-A502 Rev 0

	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:
		CUSTOMER :		QP NO.: PE-QP-999-Q-006, REV-02	DATE: 17.04.2020
		PROJECT:		PO NO.:	DATE:
		ITEM: AC ELECT. MOTORS UPTO 50 KW 415V	SYSTEM:	SECTION: II	SHEET 2 of 2

		3.NAMEPLATE DETAILS	MA	VISUAL	100%	-	IS-325 / IS-12615 / APPROVED DATA SHEET	SAME AS COL. 7	TEST/ INSPN. REPORT	✓	P	V	-	
4.0	PACKING	SURFACE FINISH & COMPLETENESS	MA	VISUAL	100%	100%	AS PER MFG. STANDARD / (#)	AS PER MFG. STANDARD / (#).	INSPC. REPORT	✓	P	W	-	(#) REFER NOTE-8

NOTES:
1. Routine tests on 100% motors shall be done by the vendor. However, BHEL/ Customer shall witness routine tests on random samples. The sampling plan shall be mutually agreed upon.
2. For exhaust/ventilation fan motors of rating up to 1.5 KW, only routine test certificates shall be furnished for scrutiny.
3. In case test certificates for these tests on similar type, size and design of motor from independent laboratory are available, the same is valid for 5 years.
4. BHEL reserves the right to perform repeat test, if required.
5. After packing and prior to issue MDCC, photographs of items to be despatched shall be sent to BHEL for review.
6. In case of any changes in QP commented by customer at contract stage, same shall be carried out by bidder without any implication to BHEL/ Customer.
7. Project specific QP to be developed based on customer requirement.
8. For export job, BHEL technical specification for seaworthy packing to be followed.
9. Packing shall be suitable for storage at site in tropical climate conditions.
10. Latest revision/ year of issue of all the standards (IS/ ASME/ IEC etc.) indicated in QP shall be referred.

LEGENDS:
*RECORDS, INDENTIFIED WITH "TICK"(√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION,
** **M**: SUPPLIER/ MANUFACTURER/ SUB-SUPPLIER, B: MAIN SUPPLIER/ BHEL/ THIRD PARTY INSPECTION AGENCY, **C**: CUSTOMER,
P: PERFORM, **W**: WITNESS, **V:** VERIFICATION, AS APPROPRIATE
MA: MAJOR, **MI**: MINOR, **CR:** CRITICAL
D: DOCUMENTATION

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Prepared by:	HEMA KUSHWAHA	HEMA KUSHWAHA	Checked by:		KUNAL GANDHI
Reviewed by:	PRAVEEN DUTTA	PRAVEEN DUTTA	Reviewed by:	RITESH KUMAR JAISWAL	RITESH KUMAR JAISWAL

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

THIS IS PART OF TECHNICAL SPECIFICATION PE-TS-497-501-A502 Rev 0

E12: AC & DC MOTORS

ATTRIBUTES/ CHARACTERISTICS → / ITEMS, COMPONENTS, SUB SYSTEM ASSEMBLY	Visual	Dimensional	Make/Type/Rating/General Physical Inspection	Mech/Chem. Properties	NDT /DP/MPI/UT	Metallography	Electrical Characteristics	Welding/Brazing(WPS/PQR)	Heat Treatment	Magnetic Characteristics	Hydraulic/Leak/Pressure Test	Thermal Characteristics	Run out	Dynamic Balancing	All tests as per IS-325/IS-4722/IS 9283	Vibration	overspeed	Tan delta, shaft voltage and polarization index test
Tan Plates for stator frame, end shield, spider etc.	Y	Y	Y	Y	Y				Y									
Shaft	Y	Y	Y	Y	Y	Y			Y									
Magnetic Material	Y	Y	Y	Y	Y		Y			Y		Y						
Rotor Copper/Aluminium	Y	Y	Y	Y		Y	Y		Y									
Stator copper	Y	Y	Y	Y			Y		Y			Y						
SC Ring	Y	Y	Y	Y	Y	Y	Y	Y	Y									
Insulating Material	Y		Y	Y			Y					Y						
Tubes for Cooler	Y	Y	Y	Y	Y				Y		Y							
Sleeve Bearing	Y	Y	Y	Y	Y				Y		Y							
Stator/Rotor, Exciter Coils	Y	Y	Y				Y	Y										Y
Castings, stator frame,terminal box and bearing housing etc.	Y	Y	Y	Y	Y			Y										
Fabrication & machining of stator, rotor, terminal box	Y	Y			Y			Y	Y									
Wound stator	Y	Y					Y	Y										Y
Wound Exciter	Y	Y					Y	Y										
Rotor complete	Y	Y					Y						Y	Y				

Exciter, Stator, Rotor, Terminal Box assembly	Y	Y					Y											
Accessories, RTD, BTD,CT, Space heater, antifriction bearing, gaskets etc.	Y	Y	Y															
Complete Motor	Y	Y	Y				Y								Y	Y	Y	Y1
Note: 1. This is an indicative list of tests/checks. The manufacture is to furnish a detailed Quality Plan indicating the practices & Procedure followed along with relevant supporting documents during QP finalization. However QP approval is not envisaged for LT motors up to 50 KW. 2. Additional routine tests for flameproof motors shall be applicable as per relevant standard. 3. Makes of all major bought out items shall be subject to Owner/Owner Engineer approval. Y1 = for HT Motor / Machines only.																		

SUB-VENDOR LIST

SUB-VENDOR LIST

ITEM CODE	ITEM/SERVICE DESCRIPTION	SL NO.	VENDOR CODE	VENDOR NAME	ADDRESS	PHONE	REMARKS
ES11	CABLE GLANDS	1	E1201	ALLIED TRADERS & EXPORTERS	C-124 A, SECTOR-2, NOIDA -201 301, UTTAR PRADESH, INDIA	Mr. Vijay Mohan Sood +(91)-(120)-2525694 +(91)-(120)-3052594 +(91)-(11)-23287156 vijay_mohansood@yahoo.com	
	CABLE GLANDS	2	E1017	ARUP ENGG & FOUNDARY WORKS	391/119,PRINCE ANWAR SHAH ROAD, CALCUTTA-700068	033 2473 0850	
	CABLE GLANDS	3	E1206	BALIGA LIGHTING EQPT.PVT.LTD.	63A,CP RAMASWAMY ROAD, ALWARPET,P.B.No 6910, CHENNAI-600018	44-24995505,22680990-4	
	CABLE GLANDS	4	E1036	COMMET BRASS PRODUCTS	NUTAN CHEMICAL COMPOUND, WALBHAT ROAD, GOREGAON, MUMBAI-400063	91-022-26852961/62/63 comet@vsnl.net	
	CABLE GLANDS	5	DW08	DOWELLS	M/S. DOWELLS ELECTRICALS 47/47A, SATGURU INDUSTRIAL ESTATE. OFF AAREY ROAD, GOREGOAN (EAST). MUMBAI 400 063.	CEO : Mr. Jayantibhai S. Patel TEL: 022-32504770,/022-29270876/ 022-29270878.	
	CABLE GLANDS	6	E1044	ELECTROMAC INDUSTRIES	27/28AF NEW EMPIRE IND.ESTT., R.KRISHNA MANDIR RD.JB NGR ,ANDHERI(E),MUMBAI-400059	91-22-28324829 / 66919034 devang@electromacglands.com	
	CABLE GLANDS	7	I01	INCAB	HARE STREET,KOLKATA,WEST BENGAL-700001	91-33-2480161/62/63/64 Fax : 91-33-2485766	
ES12	CABLE LUGS	1	E1040	DOWELLS	M/S. DOWELLS ELECTRICALS 47/47A, SATGURU INDUSTRIAL ESTATE. OFF AAREY ROAD, GOREGOAN (EAST). MUMBAI 400 063.	CEO : Mr. Jayantibhai S. Patel TEL: 022-32504770,/022-29270876/ 022-29270878.	
	CABLE LUGS	2	E1149	UNIVERSAL MACHINES LTD.	4,B.B.D.BAG (EAST) 90,STEPHEN HOUSE,5TH FLR CALCUTTA-700001	033 2282 2540	
ES16	GI CONDUITS	BIS APPROVED MAKE					
ES17	GI CONDUIT (EPOXY PAINTED)	BIS APPROVED MAKE					
ES19	FLEXIBLE CONDUIT (PVC COATED)	REPUTED MAKE					
ES53	LV MOTORS (NON FLAME PROOF)	1	A24	ABB	14, MATHURA ROAD, FARIDABAD, HARYANA-121003	0129-2567580, 09871799449	
	LV MOTORS (NON FLAME PROOF)	2	E1027	BHARAT BIJLEE LTD.	BHARAT BIJLEE LIMITED, 1ST FLOOR, 7-B, RAJINDRA PARK, PUSA ROAD, NEW DELHI - 110 060.	Tel.: + 91 (11) 25816931-33, 35 & 36| DT: +91 25724318 Fax: + 91 (11) 25819640| M:+ 91 9818 121132 www.bharatbijlee.com	
	LV MOTORS (NON FLAME PROOF)	3	C02	CROMPTON GREAVES	3RD FLOOR, EXPRESS BUILDING,9-10, BAHADUR SHAH ZAFAR MARG, NEAR ITO CROSSING,NEW DELHI-110002, INDIA	91 11 23460700 - 999 Sunil.Das@cgglobal.com	
	LV MOTORS (NON FLAME PROOF)	4	A35	GE-POWER	KAMAK TOWER, 3RD FLOOR, PLOT NO. 12-A, TVK INDUSTRIAL ESTATE, EKKADUTHANGAL, GUINDY, CHENNAI-600032	044-49681447	
	LV MOTORS (NON FLAME PROOF)	5	K01	KIRLOSKAR ELECTRIC CO LTD.	P.O. BOX 5555 , MALLESWARAM WEST ,BANGALORE 560055	Tel: +91-80-23374865 Fax: +91-80-23377706	
	LV MOTORS (NON FLAME PROOF)	6	L04	LAXMI HYDRAULICS PVT. LTD	129/130, INDUSTRIAL ESTATE PATIL NAGAR, HOTGI ROAD SOLAPUR-413003, MAHARASHTRA	0217- 2357001-005	APPROVED UPTO 200KW
	LV MOTORS (NON FLAME PROOF)	7	M01	MARATHON	MARATHON ELECTRIC INDIA PRIVATE LTD.SECTOR - 11, MODEL TOWN, FARIDABAD - 121006	Ph: +91-129-2286421, 2265340, 4006601 to 4006610	
	LV MOTORS (NON FLAME PROOF)	8	A35	NGEF	POCKET NO.10, FLAT NO. 37 & 38, EXPANDABLE DDA FLATS, NASIRPUR DWARKA, PHASE-I NEW DELHI-110 045	Ph: (011) 2539 7763	
	LV MOTORS (NON FLAME PROOF)	9	E1115	RAJINDRA ELECT INDUSTRIES	14 SHAH IND.ESTATE VEERA DESAI RD,ANDHERI(W) MUMBAI-400053	91-22-26730823, 26730789; 91)-(22)-26730154	
	LV MOTORS (NON FLAME PROOF)	10	S01	SIEMENS	RC-IN I S NR DEL AREA, JIL BUILDING, TOWER-B, PLOT NO. 78, SECTOR 18, GURGAON-122015, INDIA	0124-2842000, 9873424331 amit.bhadauria@siemens.com	
	LV MOTORS (NON FLAME PROOF)	11	HM06	HAVELLS INDIA LIMITED	Plot No. SP 181-189, Industrial Area Phase-II, Neemrana, Dist. Alwar, Rajasthan-301705, India	M: 9644355595 Mr. Kapil Jain (L): +91120-4772317 (Kapil Jain <Kapil.Jain@havells.com>)	APPROVED UPTO 200KW
ES54	LV MOTORS (FLAME PROOF)	1	E1115	RAJINDRA ELECT INDUSTRIES	14 SHAH IND.ESTATE VEERA DESAI RD,ANDHERI(W) MUMBAI-400053	91-22-26730823, 26730789; 91)-(22)-26730154	

Note:-

Make of all the equipment/instrument under this specification shall be subjected to Owner (End Customer)/BHEL approval in the event of order. The bidder may propose name of additional sub-vendors make based on their experience, which will be subject to Owner (End Customer)/BHEL approval.

Owner (End Customer)/BHEL approval reserves the right to accept/reject any make or sub-vendor after award of contract. Approval and rejection of makes shall not have any price & time implication to the purchaser after award of contract.

Annexure-E.4

Technical specification of miscellaneous items

TECHNICAL SPECIFICATION OF CABLE GLANDS AND LUGS

Cable glands shall conform to BS:6121. Cable glands shall be made of heavy-duty brass machine finished and nickel chrome plated. Thickness of plating shall not be less than 10 microns. All washers and Hardware shall also be made of brass with nickel chrome plating. Rubber components shall be of neoprene or better synthetic material and of tested quality.

Cable lugs/ferrules shall be solderless crimping type suitable for power and control cables as per the DIN 46239. Aluminium solderless crimping lugs/ ferrules shall be used for Aluminium cables and Copper lugs/ferrules shall be used for Copper cables. Bimetallic washers or bimetallic type lugs shall be used for bimetallic connections

TECHNICAL SPECIFICATION OF JUNCTION BOX

Junction box shall be made of Fire-retardant material. Material of JB shall be Thermoplastic or thermosetting or FRP type. The box shall be provided with the terminal blocks, mounting bracket and screws etc. The cable entry shall be through galvanized steel conduits of suitable diameter. The JB shall have suitable for installing glands of suitable size on the bottom of the box. The JB shall be suitable for surface mounting on ceiling/structures. The JB shall be of grey color RAL 7035. All the metal parts shall be corrosion protected. Junction box surface should be such that it is free from crazings, blisterings, wrinkling, colour blots/striations. There should not be any mending or repair of surface. JB's will be provided with captive screws so that screws don't fall off when cover is opened. JB's mounting brackets should be of powder coated MS. Type test reports for the following tests shall be furnished:

a) Impact resistance for impact energy of 2 Joules (IK07)as per BS EN50102
b) Thermal ageing at 70deg C for 96 hours as per IEC60068-2-2Bb
c) Class of protection shall be IP 55
d) HV test

Terminal blocks shall be 1100V grade, of suitable current rating, made up of unbreakable polyamide 6.6 grade. The terminals shall be screw type or screw-less (spring loaded) / cage clamp type with lugs. Marking on terminal strips shall correspond to the terminal numbering in wiring diagrams. All metal parts shall be of non-ferrous material. In case of screw type terminals, the screw shall be captive, preferably with screw locking design. All terminal blocks shall be suitable for terminating on each side the required cables/wire size. All internal wiring shall be of cu. Conductor PVC wire.

TECHNICAL SPECIFICATION OF FLEXIBLE CONDUITS

Flexible Steel Conduits shall be water proof and rust proof made of heat resistant steel with temperature rating of 150 Deg.C. Conduit diameter shall be uniform throughout its length. Internal surface of the conduit shall be free from burrs and sharp edges. Conduits shall be complete with necessary accessories for proper termination of the conduit with junction boxes.

Annexure-E.5

Load data format

TAG	LOAD TITLE	RATING (KW / A)		FULL LOAD CURRENT FLC(A)	UNIT (U)/STN. (S)	Nos.		VOLTAGE CODE*	FEEDER CODE$	CLASS OF SUPPLY #	EMER. LOAD (Y)	CONT.(C)/ INTT.(I)	STARTING TIME> 5 SEC (Y)	LOCATION OF DRIVES/LOADS	RATING & FLC CHECKED FROM MOTOR/VALVE APPROVED DATASHEET (Y/N)	BOARD NO.	CABLE		BLOCK CABLE DRG. No.	CONTROL CODE	REMARKS	LOAD No.	KKS NO.
		NAME PALTE	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	20	21	22	23	24
	NOTES: 1. COLUMN 1 TO 15 TO BE FILLED MANDATORILY.																						
	2. ABBREVIATTIONS : * VOLTAGE CODE (9):- (AC) A=11 KV, B=6.6.KV, C= 3.3 KV, D=415 V, E = 240 V (1 PH), F = 110 V (DC) : G =220V, H = 110 V, J = 48 V, K = +24V, L= -24V																						
	: $ FEEDER CODE (10) :- U = UNIDIRECTIONAL STARTER, B = BIDIRECTIONAL STARTER, S = SUPPLY FEEDER, D = SUPPLY FEEDER (CONTACTOR CONTROLLED)																						
	# CLASS OF SUPPLY---- CLASS-IV= 415V/240V NORMAL SUPPLY, CLASS-III= 415 V EMERGENCY DG SUPPLY, CLASS-II=415/240V UPS SUPPLY, CLASS-I = 220V DC SUPPLY																						
	BHEL	LOAD DATA (ELECTRICAL)		JOB NO.	528					ORIGINATING AGENCY													
				PROJECT TITLE	2X660 MW R SG					NAME				DATA FILLED UP ON									
				SYSTEM / S	HVAC PACKAGE					SIGN.				DATA ENTERED ON									
				DEPTT. /SECTION						SHEET 1/2		REV. R0		DE'S SIGN. & DATE									

Annexure-E.6

Cable Schedule Format

ANNEXURE E.6

CABLE SCHEDULE FORMAT

UNITCABLENO	FROM	TO	PURPOSE	CABLE SCOPE (BHEL PEM/ VENDOR)	REMARKS	CABLESIZE	PATHCABLENO	TENTATIVE CABLE LENGTH

Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in BHEL

1. For the purpose of clarity, it may please be noted that the information given in regard to the cables to be routed through WinPath as per the system elaborated below is called "Cable List", while the term "Cable Schedule" applies to the cable list with routing information added after routing has been carried out.

2. The cable list shall be entered as an MS Excel file in the format as per enclosed template EXT_CAB_SCH_FORMAT.XLS. No blank lines, special characters, header, footer, lines, etc. shall be introduced in the file. No changes shall be made in the title line (first line) of the template.

3. The field properties shall be as under:
    a. UNITCABLENO: A/N, up to sixteen (16) characters; each cable shall have its own unique, unduplicated cable number. In case this rule is violated, the cable cannot be taken up for routing.
    b. FROM: A/N, up to sixty (60) characters; the "From" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
    c. TO: A/N, up to sixty (60) characters; the "To" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
    d. PURPOSE: A/N, up to sixty (60) characters; the purpose (i.e. power cable/ indication/ measurement, etc.) to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
    e. REMARKS: A/N, up to forty (40) characters; Any information pertinent to routing to be specified here (e.g., cable number of the cable redundant to the cable number being entered). Information in excess of 40 characters will be truncated after 40 characters.
    f. CABLESIZE: A/N, 7 characters exactly as per the codes indicated below shall be specified here. The program cannot route cables described in any other way/ format.
    g. PATHCABLENO: Field reserved for utilization by the program. User shall not enter any information here.

4. One list shall be prepared for each system/ equipment (i.e., separate and unique cable lists shall be prepared for each system).

5. The cables shall be described as per the scheme listed below:

Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in BHEL

A	NN	A	NNN
|	|	|	|
Cable Voltage Code (see B below)	No. of cores (e.g. 01,03,3H, 07)	Cable code (See C below)	Cable size (e.g. 035,185,2.5, 0.5)

please refer below examples:

i) 3C x 120 sq. mm. (1.1kV) PVC FRLS, Unarmoured Aluminium cable, the voltage code shall be D03G120
ii) 3C x 2.5 sq. mm. (1.1kV) PVC FRLS, Unarmoured Copper cable, the voltage code shall be D03C2.5
iii) 3.5C x 120 sq. mm. (1.1kV) PVC non-FRLS, Armoured Aluminium cable, the voltage code shall be D3HF120

(A) SYSTEM VOLTAGE CODES:

(ac) A = 11KV, B = 6.6KV, C = 3.3KV, D = 415V, E = 240V, F = 110V
(dc) G = 220V, H = 110V, J = 48V, K = +24V, L = -24V

(B) CABLE VOLTAGE CODES:

A = 11KV (Power cables)
B = 6.6KV (Power cables)
C = 3.3KV (Power cables)
D = 1.1KV (LV & DC system power & control cables)
E = 0.6KV (0.5 sq. mm. Control cables)

(C) CABLE CODES

PVC Copper

A = Armoured FRLS	B = Armoured Non-FRLS
C = unarmoured FRLS	D = Unarmoured Non-FRLS

Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in BHEL

PVC Aluminium

E = Armoured FRLS	F = Armoured Non-FRLS
G = unarmoured FRLS	H = Unarmoured Non-FRLS

XLPE Copper

J = Armoured FRLS	K = Armoured Non-FRLS
L = unarmoured FRLS	M = Unarmoured Non-FRLS

XLPE Aluminium

N = Armoured FRLS	P = Armoured Non-FRLS
Q = unarmoured FRLS	R = Unarmoured Non-FRLS

S = FIRE SURVIVAL CABLES
T = TOUGH RUBBER SHEATH
U = OVERALL SCREENED
V = PAIRED OVERALL SCREENED
W = PAIRED INDIVIDUAL SCREENED
Y = COMPENSATING CABLES
I = PRE-FABRICATED CABLES
Z = JELLY FILLED CABLES

6. Once a cable list has been given to BHEL for routing, any subsequent changes required in the cable list (which may be in the form of addition of cables, deletion of cables, change of type or size of cable, etc.) must be informed as specific changes (as a separate file MS Excel of the same format as the original file) to the cable list given earlier if the cable list has been routed and cable schedule generated. The routing status of the cable list shall be got confirmed from BHEL by the agency that has prepared the cable list before the changes are intimated. In case BHEL confirms that the cable list in question has not been taken up for routing, and the revised cable list is acceptable,

the same may be sent. Since cable routing through the program involves adding each cable list to the project cable schedule database, the original cable schedule shall not be furnished to BHEL with revisions incorporated within.

SECTION: I

SUB-SECTION: C-4
TECHNICAL SPECIFICATION (C&I PORTION)

C&I TECHNICAL SPECIFICATION
FOR
VENTILATION SYSTEM

INDEX

S. No.	DESCRIPTION
1	TITLE SHEET
2	INDEX SHEET
3	SPECIFIC TECHNICAL REQUIREMENTS
4	LIST OF DOCUMENTS/DELIVERABLES
5	SPECIFICATION FOR MEASURING INSTRUMENTS
6	ELECTRIC ACTUATORS
7	SIGNAL EXCHANGE BETWEEN DRIVES & DCS
8	PROCESS CONNECTION AND PIPING
9	INSTRUMENT INSTALLATION DIAGRAM
10	INSTRUMENT STUB DETAIL
11	INSTRUMENTATION CABLE TERMINATION PHILOSOPHY
12	QUALITY ASSURANCE PLAN / CHECKLIST
13	TYPE TEST REQUIREMENT
14	PLANT AUXILLIARY SYSTEM
15	KKS TAGGING PHILOSOPHY
16	MANDATORY SPARES LIST

LIST OF DOCUMENTS/DELIVERABLES

LIST OF DELIVERABLES OF PEM - C&I DEPARTMENT			
Sl. No.	**DRAWING NO.**	**DRAWING/DOCUMENT TITLE**	**CATEGORY**
1	PE-V4-510-554-H901	CONTROL & OPERATIONAL WRITE-UP FOR THE SYSTEM WITH SET POINTS	A
2	PE-V4-510-554-H902	CONTROL SCHEME/LOGIC DIAGRAM (TO BE IMPLEMENTED IN DDCMIS)	A
3	PE-V4-510-554-H903	HMI PICTURES/PLANT SCHEMATICS	A
4	PE-V4-510-554-H904	INSTRUMENT SCHEDULE WITH SET POINTS	A
5	PE-V4-510-554-H905	I/O LIST (ANALOG & BINARY)	A
6	PE-V4-510-554-H906	DRIVE LIST/SOLENOID/ACTUATOR VALVE LIST WITH LOCATION DATA	A
7	PE-V4-510-554-H907	DATA SHEETS FOR LOCAL PANELS WITH OGA AND WIRING DETAILS	A
8	PE-V4-510-554-H908	DATASHEETS FOR INSTRUMENTS, JBs, etc.	A
9	PE-V4-510-554-H909	INSTRUMENT INSTALLATION/ HOOK UP DRAWINGS	A
10	PE-V4-510-554-H910	QUALITY PLANS (INSTRUMENTS, VMS, etc.)	A
11	PE-V4-510-554-H911	FIELD JB/RACK TERMINATIONS /GROUPING DOCUMENT	A
12	PE-V4-510-554-H912	CABLE SCHEDULE & INTERCONNECTION	A
13	PE-V4-510-554-H913	ANNUNCIATION & SOE LIST	A
14	PE-V4-510-554-H914	LIST OF SIGNAL EXCHANGE WITH DDCMIS (BOTH HARDWIRED & SERIAL INTERFACE)	A

NOTES:
ANY OTHER DOCUMENT DECIDED DURING DETAILED ENGINEERING SHALL BE PROVIDED BY BIDDER WITHOUT ANY COMMERCIAL/TECHNICAL IMPLICATION.

CONTRACTOR TO SUBMIT REUSABLE DATABASE FORMATS IN BHEL/CUSTOMER APPROVED FORMATS LIKE MS EXCEL, MS ACCESS OF DOCUMENTS LIKE INSTRUMENT SCHEDULE, I/O LIST, DRIVE LIST, FIELD JB TERMINATIONS, CABLE SCHEDULE & INTERCONNECTION, etc.
SOFT COPY OF FORMATS SHALL BE PROVIDED TO SUCCESSFUL BIDDERS.

SPECIFIC TECHNICAL REQUIREMENT

GENERAL TECHNICAL REQUIREMENTS (C&I)

1. **Complete Control & Instrumentation for Ventilation System shall be** in bidder scope of supply. Items not specifically mentioned however required for the completeness of the system shall be supplied by bidder without any commercial and time implication. The requirements given are to be read in conjunction with detailed Technical specification. Further in case of any discrepancy in the requirement, the more stringent requirement as per interpretation of customer shall prevail without any commercial and time implication.

2. The Ventilation system for main Plant area shall be controlled through DDCMIS (BHEL Scope). This DDCMIS system shall perform all functions such as auto/manual operation of valves, pumps, drives, local/remote selection of operation, status indication, annunciation, interlock and protection of pumps/drives, etc.

3. The control system for **Ventilation System shall be DCS based as per C&I Annexure-I (enclosed with this specification).** Conventional controls (hardwired 4-20mA/DI/DO) are envisaged for these packages.

4. Supply air fans, exhaust air fans & ventilation of each area shall be provided with local starter panels.

5. The fans (both supply and exhaust fans) associated with mechanical ventilation system shall be operated locally.

6. Air washer/ UAF units shall be started/ stopped by initiation from OWS provided in control room of air conditioning. Starting/ stopping of pumps shall be automatic upon such initiation.

7. The operation of the pumps shall be interlocked with the low level of water in the sump. High level of the sump shall be alarmed. The stand-by pump shall be started automatically when the working pump is stopped/ tripped.

8. High level of pressure drop across the strainer shall be annunciated.

9. Emergency stop push button shall be provided for all drives (pump & fans) for air washer Unit & UAF Unit. All other drives associated with ventilation system like supply fans, exhaust fans, roof extractor etc. shall be fed from respective MCC.

10. The status of each pump, centrifugal fans, etc. of centralized ventilation system is available on OWS in control room locally.

11. All the alarms related to failure of equipments, tripping of equipments, source of failure / reason due to which the equipment is stopped / tripped, low & high limits of parameters such as level, temperature, pressure drop, pressure etc shall be provided for each pump, fan, AWU etc. in the control system

12. The design of the control system and related equipment shall adhere to the principle of Fail safe operation of all system levels i.e the failure of signal, failure of power or failure of any component should not cause a hazardous condition and at the same time prevent occurrence of false trips and provide reliable and efficient operation of the plant under dynamic conditions.

13. All transmitters shall be smart type and shall have 4-20mA DC signal with superimposed digital communication having proven HART protocol to facilitate configuration, zero adjustment, calibration and diagnostic from remote location.

14. **Instruments used for PG test:** The control system and devices (Actuators, instruments) shall be conventional for this areas/ application. Scope of supply of PG instrument, if applicable, shall be in bidder's scope.

15. 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 are required for safe & reliable operation of plant, bidder shall supply the same without any price implication.

16. All the primary Instruments as indicated in enclosed flow schemes/diagrams and relevant tender drawings/ BOQ, corresponding Mechanical sections and meeting redundancy and other requirements specified under technical specifications are to be provided as a minimum.

17. STANDARDISATION AND UNIFORMITY OF HARDWARE:

    Bidder shall ensure that various C&I instruments /equipment like 4-20mA electronic transmitters / transducers, Temperature elements and other instruments/ local devices etc. that are being furnished by the Bidder, are of the same make, series and family of hardware to the extent possible so as to ensure smooth and optimal maintenance, easy interchangeability and efficient spare parts management.

18. 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.

19. Power supply derived for Transmitters, contact interrogation, interposing relay and solenoid shall generally be ungrounded 24V D.C only. In all cases redundancy in power modules shall be considered.

20. The solenoid operated valves shall have limit switches for open/close feedback.

21. RTD's shall be of duplex type

22. All motorized valves shall be supplied with Non-intrusive Electric Actuator (with integral starter) along with necessary interface units for linking to corresponding Control System as applicable.

23. Diaphragm seal shall be provided with Instruments having contact with corrosive, viscous media.

24. Redundancy of instruments to be provided by bidder shall be as follows: -
    (i) Triple redundancy for all analog and binary inputs required for protection of system/drives.
    (ii) For all other control functions dual redundancy of the sensors shall be provided by the bidder.

25. All instruments shall be terminated on JB/LIE/LIR/LCP in field. Number of Junction Boxes shall be sufficient and positioned in the field to minimize local cabling (max 12-15 mtrs) and trunk cable. In case grouping is not possible and these are to be installed individually, canopy with suitable mounting arrangement shall be provided.

26. Temperature transmitter shall be provided for all temperature measurement applications (as applicable). All temperature transmitters shall be suitably grouped together and mounted inside
    (i) Enclosures in case of open areas of the plant
    (ii) Racks in case of covered areas on as required basis.
    (iii) In case grouping is not possible and temperature transmitter is to be installed individually, canopy with suitable mounting arrangement shall be provided.

27. All transmitters and switches shall be suitably grouped together and mounted inside (i) Local Instruments Enclosures (LIE) in case of Open Areas of the Plant

(ii) Local Instrument Racks (LIR) in case of covered areas (iii) Local Indicators/Gauges shall also be suitably grouped in Local Instrument Racks. In case grouping is not possible and these are to be installed individually, canopy with suitable mounting arrangement shall be provided.

28. 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 equipment is protected against rain/ sunlight etc.

29. All electric actuators, pneumatic control valves, Junction Boxes, Solenoid boxes and Local control panels which are not installed inside building, suitable canopy shall be provided and design of canopy shall be approved by Employer during detailed engineering.

30. Bidder to provide Junction Boxes & SOV box in field for termination of all the instruments & solenoids respectively. For termination of single transmitters 5 nos. of TB to be used & for termination of switch 9 TBs to be used in Junction box.

31. Provision for separate Terminal block/wiring diagram for power and control blocks of control panel to be ensured.

32. 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. Double root valves shall be provided for all pressure tapping where the pressure exceeds 40 Kg./sq.cm.

33. 415 V AC Power supply shall be provided by BHEL at a single point, further distribution to various instruments/equipment of the system shall be in bidder scope. Bidder to include necessary power distribution board in his scope. Any power supply other than the above, if required by any instrument/equipment has to be derived by the bidder from the above supply & all necessary hardware for the same shall be in bidder scope.

34. Bidder to furnish electrical load/UPS load data during bidding stage on not to exceed basis.

35. Local control panel and VFD panel, if any required for operation shall be in bidder's scope.

36. Instruments must have separate tapping lines. Sharing of the same tapping pipe for redundant instruments or various different instruments is not acceptable.

37. Bidder to provide mandatory spares as per mandatory spares list.

38. At least 20% spare unused terminals shall be provided everywhere including local junction boxes, instrument racks/enclosures, termination/marshalling cabinets, etc.

39. Number of pairs to be selected for Screen /Control cable (Size : 0.5 mm2)
    a) F-Type: 2P/4P/8P/12P
    b) G-Type: 2P/4P/8P/12P

40. Number of cores to be selected for Control cable:
    a) 3 Core (Size: 2.5 mm2)
    b) 5 Core (Size: 2.5 mm2)
    c) 12 Core (Size: 1.5 mm2)

SPECIFIC TECHNICAL REQUIREMENT

25.9 **Plant control for Evaporative cooling and Ventilation system**

a) General

i. Brief scheme of controlling the operation is described below. Detailed description of the control system for safe and efficient operation of the plant shall be elaborated, got approved from Owner. The descriptions in the sub-sections of the Control & Instrument sections shall also be referred to.

b) Air Washer Units (AWU) & Unitary Air Filtration Units (UAF)

i. Air washer units shall be started/ stopped by initiation from OWS provided in control room of air conditioning. Starting/ stopping of pumps shall be automatic upon such initiation.

ii. The operation of the pumps shall be interlocked with the low level of water in the sump. High level of the sump shall be annunciated. The standby pump shall be started automatically when the working pump is stopped/ tripped.

c) Miscellaneous control requirements

i. Separate emergency local stop push button shall be provided for each pump, fans etc. of Ventilation system.

ii. The status of each pump, fans, etc of ventilation system is available on OWS in control room locally.

iii. All the annunciations related to failure of equipments, tripping of equipments, source of failure / reason due to which the equipment is stopped / tripped, low & high limits of parameters such as level, temperature, pressure drop, pressure etc shall be provided for each pump, fan, AWU etc. in the control system.

iv. The fans (both supply and exhaust fans) associated with mechanical ventilation system shall be operated locally.

v. Fully wired, twenty percent (20%) spare annunciation windows shall be provided in all the panels.

1 X 800 MW YAMUNANAGAR

C&I ANNEXURE-I

Sl. No.	System / Package	Scope of supply (Control system)	Control System		Control from		Type of interface with Main plant DCS		Communication with Main plant with DDCMIS			Redundant Time sync format	HMI REQUIREMENT	REMARKS	Rev
			Type	Location	Local	Remote	Link	Purpose	Cable Type	Redundant MICROPROCESSOR (Y/N)	Protocol				
1	Air Conditioning & Ventilation System for Main Plant (various areas like CCR/CR, CER, SWAS Room, UPS/Battery Charger Room,etc.)	EDN	Main Plant DDCMIS	CCR	Y	Y	#	-	TP/FO *	Y	-	-	1 NO. GIU (AC Plant equipment room), 1 NO. OWS is required in ESP CR	Provision of H/W interface of AC & vent system with Fire Protection.	0
2	Air Conditioning & Ventilation System for ESP Control Room	EDN	DDCMIS	ESP CR	Y	Y	#	-	TP/FO *	Y	-	-			0
3	Air Conditioning & Ventilation System for Water system control building	EDN	Water System DDCMIS	Water System CR (DM Plant)	N	Y	#	-	TP/FO *	Y	-	-			0
4	Air Conditioning & Ventilation System for Service building	EDN	Standalone DDCMIS	Service Building Control Room	Y	Y	#	-	TP/FO *	-	-	-		Provision of H/W interface of AC & vent system with Fire Protection.	2

LEGEND:

1 # Connectivity with Main Plant DDCMIS through Softlink

2 LCR- Local control room

3 FO - Fibre Optic

4 RIO - Remote Input/Output

5 CCR- Common control room

NOTES:

1 *TP/FO cable along with require accessories (at DDCMIS end) for interfacing with PLC/MP based system with DDCMIS shall be in EDN scope of supply.

SPECIFICATION FOR MEASURING INSTRUMENTS

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 minimum quantity of secondary instruments etc. to be provided by Bidder is listed in Appendix- I to Vol. V, Part A of Technical Specifications. Any other additional quantity of secondary instruments shall be envisaged by bidder as per system and process requirements 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

S. No.	Features	Essential/Minimum Requirements
1	Type of Transmitter	Sealed capacitance/Inductance/Silicon resonance type microprocessor based 2 wire type, Hart protocol (latest) 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. 100:1 for other applications.
5	Stability	± 0.15% of URL for 10 years.
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.

S. No.	Features	Essential/Minimum Requirements
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/ 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.

For Hydrogen gas pressure/differential pressure transmitters, the suitable material and coating shall be chosen as per the suggestion of transmitter manufacturer.

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 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.

S. No.	Features	Essential minimum requirements		
		Pr. Gauge/DP Gauge/Draught gauges	Temperature gauge	Level Gauge
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 CS/ alloy steel/SS as per 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.

For condensate storage tank and DM water storage tanks, the pressure gauge in terms of 0-10000 mm wc or suitable range having **dial size of 300mm or bigger size** shall be provided.

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.

Additional separate local display unit with large Alphanumeric back light LCD/LED & to be provided for the applications. Same to be decided by owner during detailed engineering.

2.04.00 Ultrasonic Type level Transmitter

S. 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.	Housing	Weather proof as per IP-65 with durable corrosion resistant coating.
8.	Adjustment/Calibration / maintenance	From hand held calibrators/ centralized OWS HART based system (as applicable)
9.	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.

S. No.	Features	Essential/Minimum requirement
10.	Sensor Material	Corrosion resistant material to suit individual application requirement.
11.	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
12.	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.
13.	Display	LCD display with integral keypad to be provided.
14.	Diagnostics	Loss of echo alarm etc.
15.	Load Impedance	500 ohms minimum.
16.	Electrical Connection	Plug and socket.
17.	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
18.	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.	

2.06.00 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. Magnesium Oxide shall be provided with high purity of 99.4% minimum.
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.	Insulation Resistance	More than 1000 M Ohms at Ambient temperature
11.	Response Time	6-10 Sec bare & 30 Sec. With protective sheath/thermowell
12.	Instrument Connection	1/2 " NPT (F).

S. No.	Features	Essential/Minimum Requirements
13.	Electrical connection	Gold plated Plug in type. Double entry, one unused entry with blind plug.
14.	Enclosure Class	IP-65 or better.
15.	Process Connection	i) M33 x 2 ii) Flanged for Air & Gas systems with mating flanges, fastner, gasket etc.
16.	Extension	Threaded union (SS316) 1/2" NPT (F) with two nipples of SS 316 having 1/2"NPT(M) threads at both ends
17.	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. Bidder may also provide Triplex Thermocouples as per process requirements.

4. Metal plug with chain is to be provided with thermowell to avoid ingress of foreign material inside thermowell when TE is not fitted or during maintenance.

2.06.02 Resistance Temperature Detector (RTD)

S. No.	Features	Essential/Minimum Requirements
1.	Type of RTD	Three wire/Four 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.

S. No.	Features	Essential/Minimum Requirements
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.	Insulation Resistance	More than 1000 M Ohms at Ambient temperature
11.	Response Time	6-10 Sec bare & 30 Sec. With protective sheath/thermowell
12.	Instrument Connection	1/2 " NPT (F).
13.	Electrical connection	Gold plated Plug in type. Double entry, one unused entry with blind plug.
14.	Enclosure Class	IP-65 or better.
15.	Process Connection	i) M33 x 2 ii) Flanged for Air & Gas systems with mating flanges, fastner, gasket etc.
16.	Extension	Threaded union (SS316) 1/2" NPT (F) with two nipples of SS 316 having 1/2"NPT(M) threads at both ends
17.	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) Metal plug with chain is to be provided with thermowell to avoid ingress of foreign material inside thermowell when TE is not fitted or during maintenance.

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 Cold Junction Compensation (CJC) Boxes

CJC Boxes are not required, Thermocouple cables shall be directly terminated at Thermocouple I/P cards only.

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	:	a) For head mounted and DIN-rail mounted type Refer note-2 RTD =<0.4% of 0-250 degC span

T/C-K type =<0.4% of 0-600 deg C span

T/C-R type =<0.4% of 0-1000 deg C span

CJC accuracy (for thermocouples) shall be =< 1 Deg C

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

CJC accuracy (for thermocouples) shall be =<1 deg C

e. Field bus compatible temperature transmitters:-

Temperature transmitters of this category shall be field mounting type & shall be capable of withstanding operating ambient temperature upto 85 deg C. These modules shall be connected to DDCMIS through field bus such as Profibus, Foundation Field bus etc directly from the transmitter. Maximum Number of inputs per such temperature transmitter shall be eight. These shall be mounted in cabinets 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.

3. For BFPs' differential temperature protection by 2 out of 3 logic, DTT shall be employed to deliver 4-20 mA output to DDCMIS using suction & discharge temperature measurements.

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.

microns. Weather and water proof enclosure. Built in blow down valve shall be provided. AFR shall have automatic drain feature. Material of accessories will be SS316. Body material of Air Filter regulator shall be Die Cast Aluminum or SS316. Degree of protection shall be IP 65.

Air filter regulators shall be provided in the :

(a) Air supply line to valve positioners / power cylinders.
(b) Air supply line to electric to pneumatic converters.
(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.

2.13.00 PROCESS ACTUATED SWITCHES

S. 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

S. No.	Features	Essential/Minimum Requirements		
		Pressure/Draft Switches/ DP Switches	Temperature switches	Level switches
				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. Differential shall be adjustable.		
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 (wherever Required)	24 V DC, to be arranged by Bidder except for Ash Level Switches, where the same shall be as per Bidder's Standard practice.		

Notes:-

1) Where the process fluids are corrosive, viscous, solid bearing or slurry type, diaphragm seals shall be provided. Parts below the diaphragm shall be removable for cleaning. The entire volume above the diaphragm shall be completely filled with an inert liquid suitable for the application.

2) Pressure / Diff Pressure switches for very low 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.

4) All the Pressure/ Diff. Pressure/ Temp./ Level switches etc. shall be with the provision of local digital display.

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
flame		For NEC Class-1/2, Division 1 area)/ proof (IEC-79.1, Part I). As applicable).

3.	Relay Output	:	2 Nos. Relay Changeover Potential Free Contacts (2 SPDT)
4.	Contact Rating	:	5A at 240 V AC & 0.25 at 220V 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

2.13.04 FLOW SWITCHES (FS)

1.	Type	:	Differential pressure type / vane actuator type, as per application.
2.	Materials		
	Body & Sensing Elements	:	SS316
	Case	:	Die-cast aluminum
	Wetted Part	:	SS316
3.	Accuracy	:	± one (1) percent Repeatability
4.	Set point	:	Adjustable through range
5.	Contacts		
	No. of contacts	:	DPDT or 2 sets of SPDT

	Type	:	Snap action micro switch
	Rating	:	5 Amp 240V AC 0.2 Amp 220V Dc
6.	Connection		
	Instrument	:	1-1/2 or 1 inch NPT Male or Flanged or with SS316 Tee as per requirements.
	Electrical	:	Suitable for gland 3/4 inch & Plug in type.
7.	Protection Class	:	IP-65/ (Explosion proof for NEC Class-1, Division 1 area)/ flame proof (IEC-79.1, Part I). As applicable).
8.	Accessories	:	As required

2.14.00 SOLENOID VALVES

Solenoid valves shall be provided as per NAMUR standard with control valves / pneumatic control valves hooked up with process interlock requirements and where direct tripping is involved. The number of ways for solenoid valve shall be provided as indicated below:

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.

f. For operation of the fuel oil corner nozzle valves, fuel oil trip valves etc., **double coil solenoid valve** (latch coil & relatch coil) shall be adopted.
Single coil usage requires always power and loss of power leads to closure of above valves resulting the unit trip or loss of generation.

g. Two (2) way solenoid valves shall be provided, where process line of less than 50 mm with low pressure and temperature application.

h. Three (3) way solenoid valve shall be provided commonly, where the pressure is admitted or exhausted from a diaphragm valve or single acting cylinder, e.g, Pneumatic operated spray water block valve.

i. Four (4) way solenoid valve shall be provided for operating double acting cylinders, e.g, Pneumatically operated on-off type dampers.

j. Solenoid valve shall operate on 24 V DC, UPS 230 V AC or 220 V DC as per system requirements.

2.16.04 Parshall Flume

The Bidder shall provide all the control and Instrument devices including primary sensors, transmitters, flow indicator cum integrator / totaliser and shall include all required accessories for the flow measurement of raw water through the clarifier. The system shall be of reputed make and acceptable to the owner.

Level measurement shall be based on ultrasonic/rador technology. The flow compensation is to be implemented in the transmitter itself. The transmitter shall provide 4-20 mA DC in direct proportion to flow and shall be able to drive a load impedance of 500 ohms minimum

Accuracy shall be +/- 0.25 % or better.

All the mounting hardware and accessories required for erection and commissioning of the same are to be provided by the bidder. Mounting fittings material shall be SS316. All weather canopy is to be provided for electronics/sensor to protect the same from rain/ sunlight etc.
Additional separate local display unit with large Alphanumeric back light LCD/LED & to be provided for the applications which will be decided during detailed engineering.

The Type makes and models no. shall be subject to Owner's approval.

2.16.05 Electronic Flow-Meter

The electronic flow meter shall include flow sensor and flow indicator cum integrator / totaliser and shall include all required accessories for satisfactory operation. The flow meter shall be based on full bore ultrasonic / electromagnetic principle and shall be electronic type of proven design, make and model acceptable to the owner.

The Bidder shall submit all necessary technical literature and details of selection criteria of the instrument offered to substantiate the model selected. The Bidder shall also furnish list of similar installation along with feed back on satisfactory performance of the instruments.

The flow meter shall meet or exceed the following requirement:

(a)	Output	4-20 mA DC Isolated output HART compatible
(b)	Accuracy	± 0.5% of calibrated span or better *
(c)	Repeatability	± 0.2% of calibrated span or better
(d)	Ambient Temp. &	4 deg.C to 55 deg.C.
	Humidity	5% to 100% RH
(e)	Power Supply	UPS 240V AC ± 10%, 50 HZ ± 5%/ 24 V DC, to be arranged by the bidder.
(f)	Protection class	IP-65
(g)	flange material, Measuring tube & electrode material	SS 316

(h)	Liner material.	Teflon.
(i)	Features	zero stability, zero and span field adjustable, suitable for process medium with >= 5 micron Siemens conductivity.

The flow meter shall provide local indication for instantaneous flow. It should also be possible to get local display for daily and monthly discharge. The flow meter shall indicate totaliser / integrator to get the daily and monthly discharge as stated above.

2.17.00 AC PLANT AND COMPRESSOR RELATED SPECIAL INSTRUMENTS

2.17.01 (HUMIDITY SENSOR)

Sensor	:	Capacitance type
Accuracy	:	+/-3% R.H
Range	:	0-100%
R.H Output	:	4-20 ma
Time constant	:	2 mins.

Output from the sensor is to be connected to respective control system. Bidder can also provide combined instrument for measurement of humidity and temperature subject to Owner's approval during detailed engineering. In all such cases, 4-20 ma outputs, each for temperature and humidity measurements are to be provided.

2.17.02 TEMPERATURE/ HUMIDITY INDICATOR

Sensor	:	RTD for (Pt 100) for temperature
	:	Capacitance Type for Humidity (specs for humidity and temperature shall be as mentioned above)
Display	:	Combined enclosure with two three digit seven segments LED display with decimal point after two digits. LED height shall be 4 inches, clearly legible from a distance of at least 10 meters.
Range	:	0-60 Deg C for temperature.
	:	0-95.0 % for Relative Humidity.
Accuracy	:	Better than +/_0.5 % for Temperature
	:	Better than +/_2.5 % for Relative Humidity
Mounting	:	Table Top/ wall mounting.
Power supply	:	240 V AC, 50 Hz.
Output	:	4-20 mA signal each for temperature.
Qty.	:	15 nos. each of temperature & Humidity indicators (combined indicators for Humidity and temperature is also applicable).

One Set of output signal is to be connected to respective control system. Apart from displaying the temperature/humidity values on indicator.

2.17.03 DEW POINT METER

Type	:	2 Wire Loop Powered Dew point Transmitter
Overall Range	:	-60°C to +20°C Dew point
Accuracy	:	± 2°C Dew point
Material	:	SS316 (wetted parts)
Features	:	a) AUTOMATIC CALIBRATION

(b) Can be Configured for Linear 4-20mA signal in °C & °F Dewpoint, ppm(v), ppb(v), g/m3
(c) Temperature Compensation
(d) Failure Diagnostics
(e) Long Term Stability
(f) Fast Response
(g) IP 66 / NEMA4X Protection
(h) Supplied with Calibration Certificate Traceable to National & International Humidity Standards
(i) Sensor protection with sintered filter
(j) Local LCD Display for Dew Point

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.

ELECTRIC ACTUATOR

CHAPTER – 17

ELECTRICAL ACTUATORS WITH INTEGRAL STARTERS

17.01.00 **SCOPE**

17.01.01 This Specification covers the general requirements of Electric Motor Actuators for valves, dampers and gates.

17.01.02 All electric motor actuators shall be furnished in accordance with this general specification and the accompanying driven equipment specification.

17.01.03 Actuators shall be designed to ensure proper function in accordance with specifications given below and complying to EN15714-2 or equivalent.

17.02.00 **CODES & STANDARDS**

All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) / IEC mentioned in Chapter 37 except where modified and / or supplemented by this specification.

Equipment and material conforming to any other standard, which ensures equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted shall be furnished during detail engineering.

The electrical installation shall meet the requirements of Indian Electricity Rules as amended up to date and relevant IS Code of Practice. In addition, other rules and regulations applicable to the work shall be followed.

17.03.00 **SERVICE CONDITIONS**

17.03.01 The actuator shall be integral type and suitable for operation in a hot, humid and tropical atmosphere, highly polluted at places with coal dust & fly ash and shall be suitable for an ambient temperature ranging from (-) 20 deg C to (+) 70 deg C.

17.03.02 Actuators for explosion-hazardous applications shall in addition be certified Flameproof for Zones 1 and 2 (Divisions 1 and 2 Group gases).

17.04.00 **RATING**

17.04.01 Supply Voltage & frequency: 415V +/- 10%, 3 Phase, 3 Wire, 50HZ +/-5%.

17.04.02 Sizing:-

i) For Open/Close at rated speed against designed differential pressure at 90% of rated voltage.

ii) For isolating service:- three successive open-close operations or 15 minutes, whichever is higher. For regulating service 150 starts per hour or required cycles, whichever is higher.

17.04.03 Control voltage of the motor starter shall be 110V AC. Power supply to electrical actuators shall be backed up with reliable battery supply.

17.05.00 **PERFORMANCES**

The actuator shall meet the following performance requirements:

17.05.01 Open and close the valve completely and make leak-tight valve closure, without jamming.

17.05.02 Attain full speed operation before valve load is encountered and impart an unseating blow to start the valve in motion (hammer blow effect).

17.05.03 Operate the valve stem at standard stem speed and shall function against design differential pressure across the valve seat.

17.05.04 The motor reduction gearing shall be sufficient to lock the shaft when the motor is de-energised and prevent drift from torque switch spring pressure.

17.05.05 The entire mechanism shall withstand any shock resulting from closing with improper setting of limit switches or from lodging of foreign matter under the valve seat.

17.06.00 **SPECIFIC REQUIREMENT**

17.06.01 Construction

i) The actuator shall essentially comprise the drive motor, torque/ Position limit switches, gear train, clutch, hand wheel, position indicator and transmitter, inbuilt thermostat for overload protection, single phase preventer protection, space heater and internal wiring. Actuator shall be integral type. Integral starters shall have two sets of torque and limit switches for independent hook-up with plant DCS logic and electrical logic/interlock. All actuators shall be certified for SIL 2 or better.

ii) The actuators shall be Non-intrusive electric actuators with accessories. All actuator settings including torque, limit shall be possible without opening the actuator cover and LCD indication shall be available integral to actuator body.

iii) The actuator enclosure shall be totally enclosed, dust tight, weatherproof (NEMA-6/IP-68) suitable for outdoor use without necessity of any canopy.

iv) All electrical equipment, accessories and wiring shall be provided with tropical finish to prevent fungus growth.

v) The actuator shall be designed for mounting in any position without any lubricant leakage or operating difficulty.

vi) A lockable local/remote selector switch shall also be provided for selecting mode of operation.

vii) Gear Train:-Metal (Fibre gears are not acceptable) self-locking to prevent drift under torque switch (where ever applicable) spring pressure when motor is de-energised.

viii) Manual Wheel:- Shall disengage automatically during motor operation.

ix) Duty cycle of actuators shall suit the system requirement. The actuators shall be capable of giving the required torque at the output shaft. The actuators shall be designed to take the full thrust

x) 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.

xi) A three-position selector switch (marked as LOCAL-OFF-REMOTE) and push buttons OPEN-STOP-CLOSE (for local operation) with indication lamps for running OPEN and running CLOSE shall be provided.

xii) The Remote command signal (OPEN-STOP-CLOSE) from DCS/Respective control system/Control panel shall be isolated from control electronics through opto-isolator.

xiii) The following individual status annunciation LED's (Colour-Green) shall be provided locally (Integral to actuator) to annunciate the following for easy local monitoring. The local status display of actuator shall be clearly understandable by operator (Display of instruction should be clearly mentioned in the name plate i.e., operation alarm and fault indication).

- 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

xiv) The following individual fault annunciation LED's (Colour-Red) shall be provided locally. (Integral to Actuator)

- Torque switch OPEN
- Torque switch CLOSE
- Thermo switch trip
- Electronic overload relay trip
- Motor single phasing
- Common fault (Inclusive of any one or combination of above fault)

xv) View port shall be provided on integral starter unit to monitor the above status annunciation and fault annunciation.

xvi) Electronic overload relay shall be provided to trip actuator in case of overload. Plug in connections/design shall be provided between:

- Integral starter unit and basic actuator
- Between external customer connections and actuator

xvii) OPEN-CLOSE indication /LED shall be provided for indication of full open/close position.

xviii) Automatic phase correction facility and potential free contact for annunciation of power failure shall be provided.

xix) All required accessories (if applicable) for calibration/ settings/ configuration of various parameters of actuator shall be provided.

17.06.02 Motor

i) The squirrel cage induction motor shall be designed for full voltage direct-on-line start, with starting current limited to 6 times full-load current. The motors shall otherwise generally confirm with technical specification for motors mentioned elsewhere in this specification.

ii) The actuators shall be sized so as to open or close valves/ dampers at rated speed.

iii) Motor insulation shall be class B or better. With Temperature rise not more than 70 degree 'C' over ambient temp. of 50 deg.C. The actuators shall be suitable for a relative humidity of 95%.

iv) Performance:-The motor shall be capable of:

a) Starting at 85% of rated voltage
b) Running at 80% of rated voltage at rated torque for 5 minutes
c) Running at 85% rated voltage at 33% excess rated torque for 5 minutes.

v) Maximum continuous motor rating shall be atleast 10% above the maximum load derived of the driven equipment under entire operating range including voltage & frequency variation.

vi) Bearing

The motor bearing shall be double shielded, grease lubricated and antifriction type.

vii) Earthing

At least two earthing terminals shall be provided for the motor body. Separate earting terminal should be provided for terminal box.

viii) Protection:-The following electrical protections should be provided for the motor:-

a) Single Phasing Protection
b) Overload Protection
c) Overheating protection through thermostat
d) Wrong Phase Sequence Protection

ix) 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.

x) The actuators shall be flange mounted to valve bonnets or with gearing and disengaging hand wheel for dampers.

17.06.03 Limit Switches

i) Each motor actuator shall have Six (6) rotary drum position limit switches with two for open each with 2 NO + 2NC contacts and two for close each with 2 NO + 2 NC contacts positions, each with adjustable setting between fully open and fully closed positions. Each rotary drum limit switch shall have two (2) limit switches for intermediate open position each with 2 NO + 2 NC contacts. The limit switches shall have capacity of 5A at 240V AC or 0.5A at 220V DC.

ii) Each motor actuator shall also have two (2) torque limit switches with two (2) normally opened and two (2) normally closed contacts each.

iii) The torque switches shall have a minimum accuracy of 3% of set value. The torque switches shall be provided with calibrated knobs for setting desired torque and separate knobs shall be provided for open and close torque switches. The torque and position limit switches shall be housed in a separate enclosure with protection class as that of actuator.

iv) The motor operators/actuators shall be capable of meeting 150 percent of unseating torque at specified voltage.

v) The motor actuators shall have 2 nos. potentiometric type transmitters of 100-ohm rating.

vi) Torque switches shall function to stop the motor on closing/opening. Upon actuation by the torque clutch it is restricted its attempt to open or close, thereby causing an overloading torque. Torque switches shall be self-resetting type only (i.e.) once a particular direction torque switch operates, it shall get resetted only when the equipment is operated in other direction.

vii) All six (6) limit switches shall be changeover type and adjustable besides having the snap facility. All limit switches, contacts shall be wired up independently upto the terminal block.

17.06.04 Position Indicator/Transmitter

i) Motor actuators shall be provided with clearly visible local position indicators mounted on the operator assembly itself. Suitable transducers shall be provided for remote indication of the position.

ii) To be provided for 0 to 100% travel.

iii) As required. Suitable for stabilized 4-20 mA signal, 2 wire inductive type, 24 volts DC operated.

17.06.05 Hand Wheel

Hand wheel shall enable manual operation in case of power failure but it shall get automatically disengaged when once the motor starts functioning. The effort required to operate manually shall not exceed 18 Kg.

17.06.06 Space Heater

Provision of space heater, if necessary, shall also be made with servomotor limit switch compartments. The space heaters shall be suitable for operation at 240V AC and its rating shall be indicated by the tenderer. Space heater circuit shall be complete with thermostat.

17.06.07 Terminal Box

i) The terminals, terminal boards, terminal boxes, winding coils and associated equipments shall be suitable for connection to supply system having short circuit capacity specified in data sheet and clearance time determined by associated fuses. The terminal boxes shall be totally enclosed.

ii) 1100V grade for power cables.

17.06.08 Wiring

i) All wiring connections for various limit and torque switches, space heaters, position transmitters shall be brought out on separate terminal boards mounted on the valve, having liberal space for wiring and making connections to Owner's external circuits. Plug in type/ screw terminals shall be used suitable for analog/digital application. There shall be at least 5 terminal spare to terminate spare cores of cable. Size of each control terminal shall be such that two (2) nos. lugged 2.5 sq.mm cable can be terminated on each side. Power terminals shall be suitable for termination of 6 sq.mm lugged wire or as required depending on the motor capacity.

ii) Motor terminal box and actuator terminal box shall be provided with double compression cable glands to suit cable type and size and copper lugs for cables.

iii) Adequate earthing terminals preferably not less than 8 SWG GI wire shall be provided for suitable earthing system. Two earthing terminals shall be provided per motor, one No. on either side of the motor.

17.06.09 Interfaces:

i) Open/Close command termination logic with position & torque Limit Switches, positioner circuit shall be suitably built in the PCB inside the actuator.

ii) The following individual potential free relay contacts shall be provided in the actuator for remote annunciation to facilitate continuous monitoring of the actuator.

- Actuator (valve) running in OPEN direction.
- Actuator (valve) running in CLOSE direction.

- Actuator in remote mode.
- Actuator in local mode.
- Actuator power switched off /single phasing.
- Torque switch trip, thermo switch trip and overload relay trip
- And as also as per drive control philosophy

iii) Interface with the control system shall be through hardwired signal only. Inter posing relays provided (with coil burden 2.5 VA) in the actuator shall be energized to initiate opening and closing, by 24V DC signal from the external control system.

iv) For Modulating Drive:- the command to actuator shall be in form of 4-20mA signal. The necessary positioning circuit and motor protection shall be provided.

iv) Open/close command termination logic shall be suitably built inside actuator.

17.06.10 Name Plate

Name plate shall be provided on the actuators with at least following data (a) Tag no. (b) Torque Rating (c) Full travel time.

17.06.11 Painting

The actuator shall be painted with epoxy based paint (the colour shall be indicated by the supplier). Paint shade shall be as mentioned in Chapter 1.

17.06.12 Packing

The actuators shall be properly packed for transport by rail/ road/sea as applicable.

17.06.13 Overload Protection

The actuator motor shall be provided with integral starter along with thermostat for overload protection.

17.06.14 Tests

i) The actuator and all components thereof shall be subject to routine factory tests as per relevant IS Standards. In addition, if any special test is called for in equipment specification, the same shall be performed.

ii) Following routine test shall be conducted as per IEC/IC standard. (a) Meggar Test, (b) Continuity test, (c) Operational test. Test certificates duly signed by inspecting agency shall be furnished.

iii) The actuator shall be type tested as per IEC/National Standard, by international/national recognized test house. The test certificates issued by this house shall be furnished.

iv) Test Witness

Tests shall be performed in the presence of Owner's representative so desired by the Owner. The Bidder shall give at least fifteen (15) days advance notice of the date when the tests are to be carried out.

17.06.15 Drawing and Manuals

Bidder shall submit the following minimum drawings/ data and Manuals for approval:

i) Instruction manuals on Installation, tests
ii) Actuator Data sheet.
iii) Internal wiring diagram and control schematic.
iv) Torque switch and Limit switch contact development.
v) QAP for Test reports.
vi) Manufacturers Catalogue
vii) Instruction manuals on installation methods. tests etc.
viii) Motor sizing calculation
ix) Integral starter details
x) General arrangement drawings
xi) Test reports-The type test reports from Govt. Recognized lab shall be treated as reference.
xii) Manufacturing quality plan
xiii) Field quality plan

17.06.16 Training

Bidder shall provide training on Non-intrusive hardwired Electric Actuator for Owner's personnel.

17.06.17 Mandatory spares

Mandatory spares for actuator shall include 10 % or 1 No. of each type, class, size and make, whichever is more.

DATASHEET

1.0	**Auxiliary power supply**	
1.1	415V, 3Φ, 3W, 50 Hz. Fault level 50 kA symm for 1 sec.	Motors above 200 W and including 160kW
1.2	240V, 1Φ, 2W, 50 Hz effectively earthed	Motors including 200 W and below. Lighting, space heating, AC control and protective devices
1.3	**DC supply**	
	220V,2W, unearthed. Fault level 25 kA for 1 sec.	DC alarm, control and protective devices.
	Fault level	25 kA for 1 second
2.0	**Range of variation**	
2.1	AC supply	
	voltage	± 10%
	Frequency	± 5%
	Combined voltage & frequency	10% (Absolute sum)
2.2	DC supply	187 to 242 V

LOCAL CONTROL PANEL

CHAPTER – 6

SUPERVISORY CONTROL PANELS, SUPERVISORY CONTROL DESKS, EQUIPMENT PANELS

6.00.00 CONTROL DESK & PANELS

6.01.00 General

6.01.01 All control desk, panels, LVS panel etc. shall be furnished fully wired with necessary provision for convenience outlets, internal lighting, grounding, ventilation, space heating, anti- vibration pads, internal piping & accessories as required for completeness of the system.

All panels, desks, cabinets shall be free standing type & have bottom / top entry for cables to be finalised application wise during detailed engineering stage. The bottom of desk & cabinets shall be sealed with bottom plate, compression cable glands (double for field and single for inside rooms) and fire proof sealing material to prevent ingress of dust and propagation of fire. Sufficient number of power receptacles with disconnect switches shall be installed within all panels/desk.

6.01.02 Exterior steel surface shall be sand blasted, ground smooth, filled, primed, sanded and smooth enamel painted to give a good finish subject to minimum paint thickness of 65-75 microns for sheet thickness of 3 mm and 50 microns for sheet thickness of 2mm. The exact color shall be finalised during detailed engineering.

6.01.03 The design shall conform to the EN ISO 11064-6:2005 (Ergonomic design of control centres, Part 6/latest). Bidder shall furnish documentary proofs/ evidences/certifications in support of same along-with the Bid, stating compliances for the entire aspects covered under the ISO standard.

6.02.00 CONTROL DESK & PANEL

6.02.01 The exact dimensions, material, construction details, grounding, general arrangement etc. of Control Desk etc. shall be as per the actual requirement and shall be finalised during detailed engineering and subjected to Owner's Approval. For bidding purpose, the minimum length of the desk/ panel and CD mounted devices are given in Appendix-I to Part-A, Volume V.

6.02.02 For control desk mounted instruments/ devices etc., which are to be powered from UPS, all required conversion of interface equipments / accessories to make such devices compatible with UPS supply shall be provided. All necessary hardware like Input switches/ fuse unit for each feeder as well as switch fuse unit for each instrument/ device on the power supply line shall be provided. From UPS, redundant feeders shall be provided with suitably rated MCB and provision of fast auto changeover of UPS feeders.

6.10.00 **CONSTRUCTIONAL FEATURES OF LOCAL CONTROL PANELS, CONSOLES, CONTROL Desk, CUBICLES & ENCLOSURES**

i. All type of panels, control panels, cubicles, consoles, SOV panels, GIU panels, Fire alarm panels and enclosures provided anywhere for subject plant per this specification shall be of free-standing type with modular construction and shall be constructed of specified gauge of sheet steel (Industrial grade- Grade D) as per IS 513 depending on location with Multi-folded frame-based structure (Minimum 9-folded Profile) made from a single sheet. Panels with multi folded profiles shall be mandatory for all types of DDCMIS, DCS and PLC panels. The minimum sheet thickness of panels shall be as follows unless otherwise specified herein.

Side and top – not less than 1.5 mm
Door – not less than 2.0 mm
Mounting plate –3mm GI
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. Doors shall be reversible type, left hinged as a default, with 130-degree swing. Door latches shall be of the 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. Doors should come with double bit cam locks to ensure rigid and inposition locking which provides consitent IP protection and avoids entry of external substances/dust/water.

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 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. Properly installed grounding and potential equalization of various electrically conductive parts in order to compensate for voltage differences between conductive parts shall be preliminary design requirement for all the panels/enclosures to be met by the Bidder.

iv. In each panel /cabinet installed in common control room a 24 VDC/ 230 VAC Voltmeter digital type shall be provided to check all the (AC/ DC) 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 polyurethane gasket only (Durometer hardness as per ASTM D2240-97/e1) with sustainable IP throughout product life. 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.

xvi Salt spray tests shall be conducted in accordance with ISO 9227:2012(en) i.e. Corrosion tests in artificial atmospheres.

xvii. Enclosure Protection class against external mechanical stresses shall be of IK09 standard as per EN 50102/IEC 62262 for all type of panels/enclosures. Dynamic material strength and vibration resistance shall be as per IEC 60068-2-6.

xviii. Complete panels/enclosures for project plant shall be tested and certified according to manufacturing standard IEC 62208. (the IEC 62208 standard requires the IP and IK to be declared and verified)

xix. Complete panels/enclosures for project plant shall be tested and certified for level C4H, high corrosivity according to ISO12944 (> 15 years to first major maintenance)

xx. Complete panels/enclosures for project plant shall be RoHS compliant, UL and TÜV Rheinland certified and shall be tested/certified according to IEC 60529 and latest IEC 62262 standard (i.e the latest applicable standard at the time of bid opening)

xxi. Complete panels/enclosures for project plant shall be Tested and certified according to Electrical protection Class II IEC 60950-1, IEC 61439-1 standard, UL508A standard, IEC 60297-3-100 standard and IEC 61696-3 standard.

xxii In each panel /cabinet installed in Common Control Room (CCR) a temperature indicator digital type shall be provided for monitoring of temperature of individual panels/ cabinet.

xxiii All the control panels shall be separated power and instruments/ electronic grounding.

xxiiii The design of panels, cabinets, enclosures and packaging density of components mounted therein shall be such that the temperature rise

does not exceed 10 deg. C above the ambient under the worst conditions.

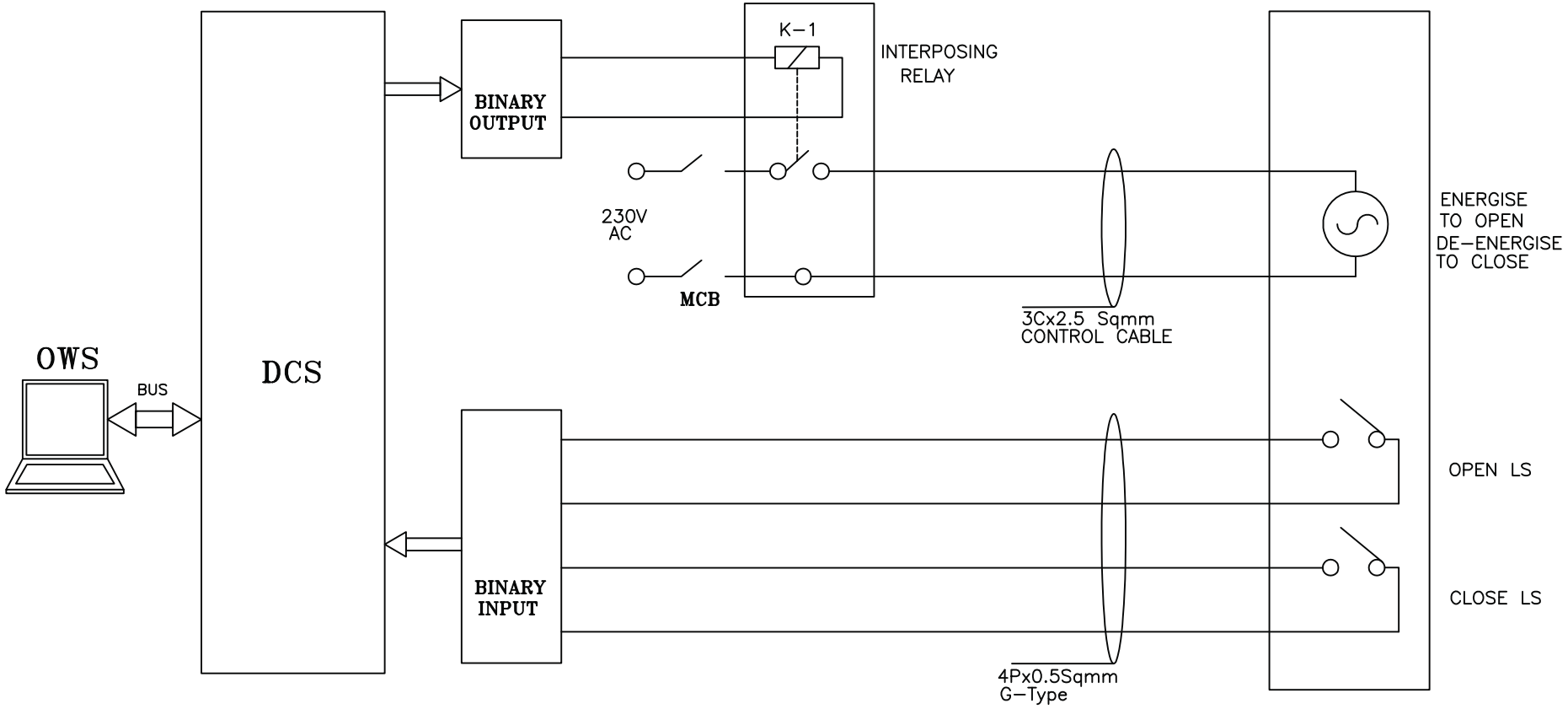
xxiiv Enclosures for peripheral equipment like printers, etc. shall take care of noise and shall ensure minimum possible noise disturb to the working personnel.

xxiv All panels, desks, shelters, cabinets, consoles & enclosures installed under the open/outdoor environment shall be provided with lightening protection system as per system requirements.

xxivi Guards, barriers and access doors, covers of plates shall be marked to indicate the hazard, which may occur upon removal of such devices. Danger or caution signs shall be used to warn of specific hazards such as voltage or current. The marking shall be permanently affixed to the equipment.

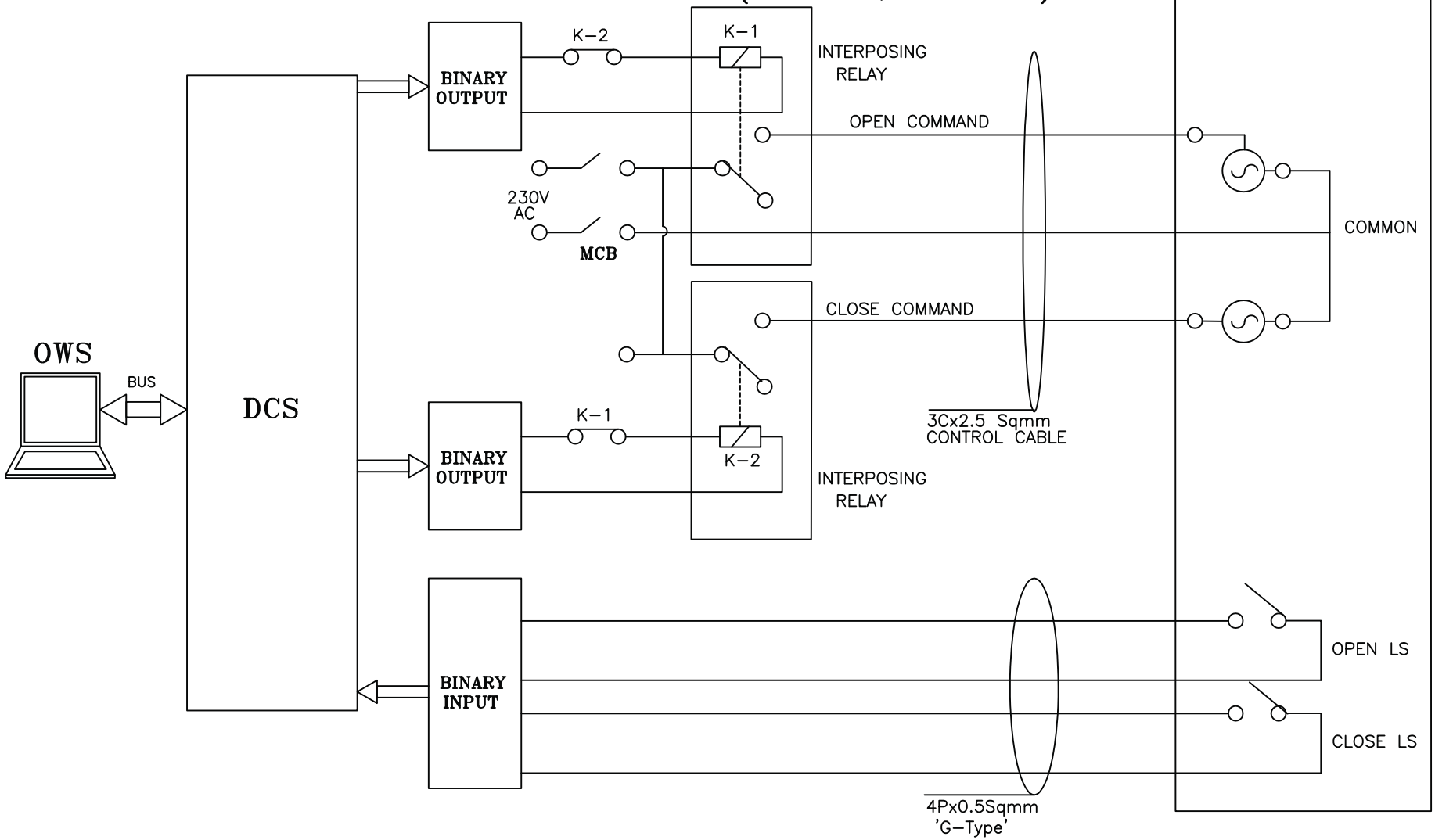
SIGNAL EXCHANGE BETWEEN DRIVES & DCS

DCS INTERFACE FOR MOTORIZED OPERATED FIRE DAMPER (BID–FD)



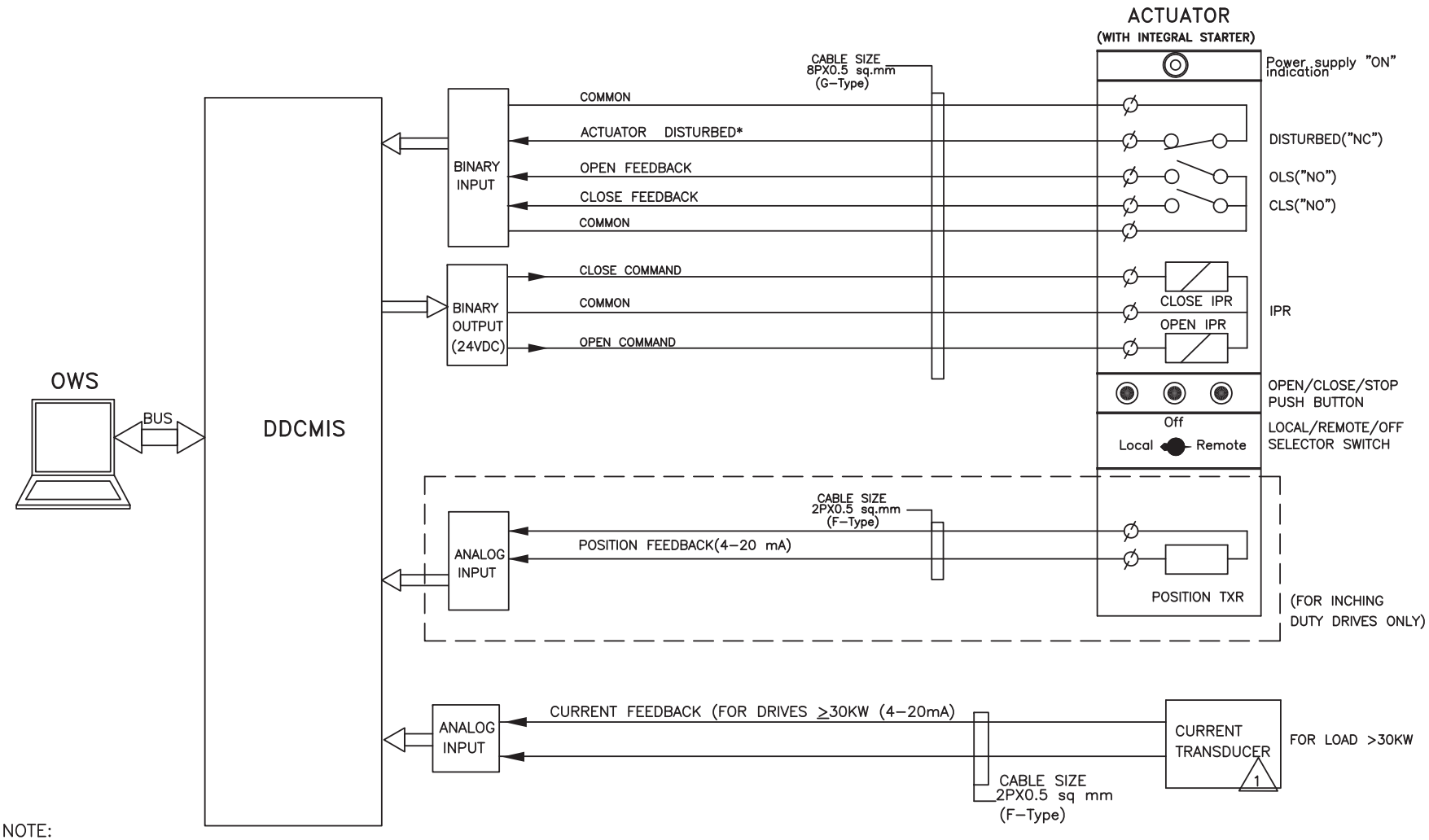
BHEL	PROJECT: 1x800 MW YAMUNANAGAR TPP	DRG.NO.	
		DATE	
	TITLE: DRIVE INTERFACE SCHEME	REV.NO.	
		SHT 3 OF 6	

DCS INTERFACE FOR MOTORIZED OPERATED VALVES (BID-AC,BID-VCD)



PROJECT:	1x800 MW YAMUNANAGAR TPP	DRG.NO.	
		DATE	
TITLE:	DRIVE INTERFACE SCHEME	REV.NO.	
		SHT 6	OF 6

DDCMIS INTERFACE FOR BIDIRECTIONAL DRIVE(WITH INTEGRAL STARTER)



NOTE:

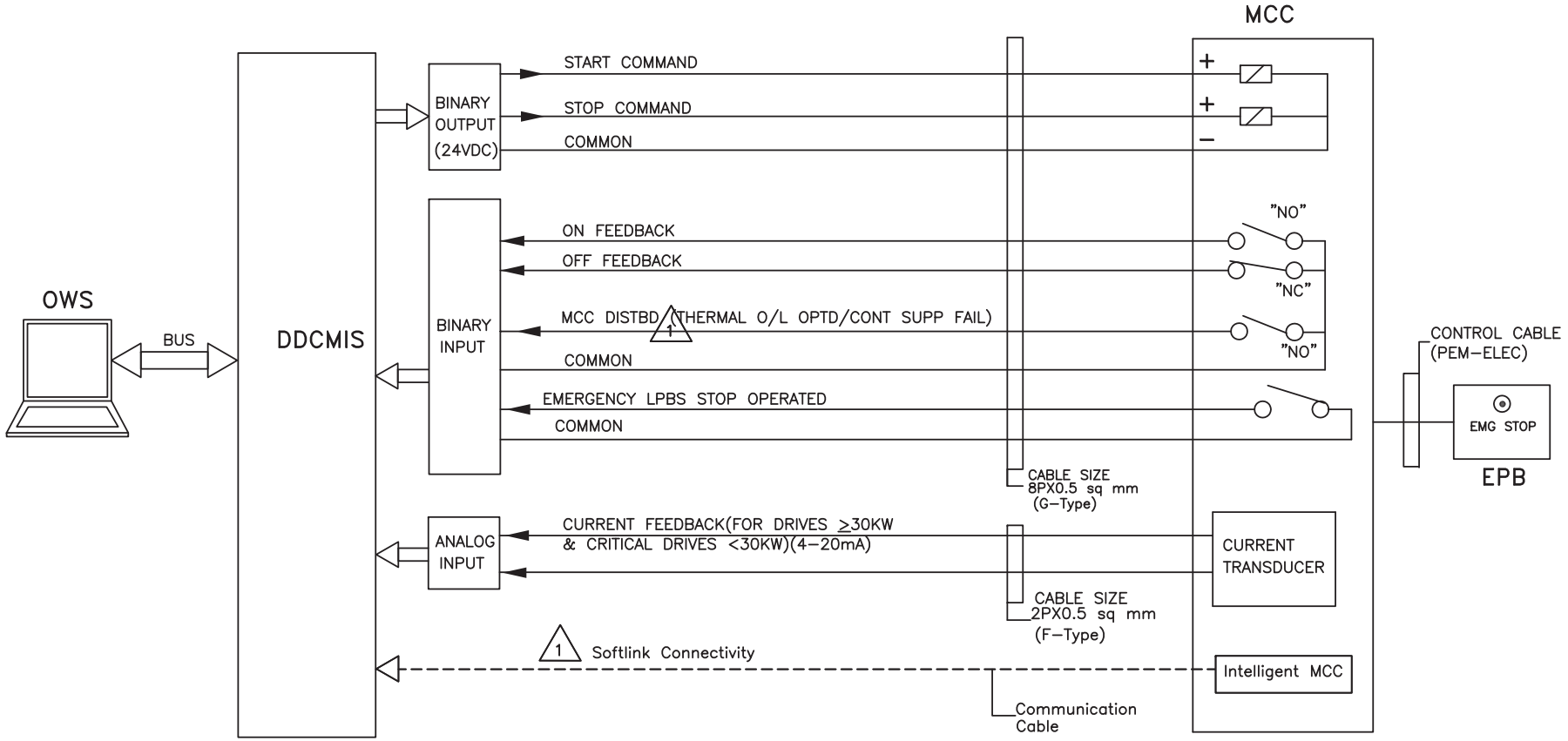
1. * DISTURBED= LOSS OF POWER SUPPLY (1 PHASE/3 PHASE)/
   LOSS OF CONTROL SUPPLY/ THERMAL OVER LOAD /
   LOCAL/REMOTE SEL. SWITCH IN LOCAL

2. POSITION FEEDBACK OF BIDIRECTIONAL INCHING DUTY DRIVES IN VICINITY MAY BE GROUPED TOGETHER IN THE FIELD DURING CABLE ENGG. USING JUNCTION BOXES & SINGLE TRUNK CABLE OF HIGHER SIZE MAY BE USED TO CONNECT.

3. REDUNDANCY OF IOs SHALL BE AS PER CONTRACT SPECIFICATION REQUIREMENT.

PROJECT: 1x800MW YAMUNANAGAR STPP		DRG.NO. PE–DM–510–145–H002
1	DDCMIS INTERFACE FOR BIDIRECTIONAL DRIVE	DATE 20.12.2024
		SHT 6 OF 10

DDCMIS INTERFACE FOR UNIDIRECTIONAL LT DRIVE (CONTACTOR OPERATED)

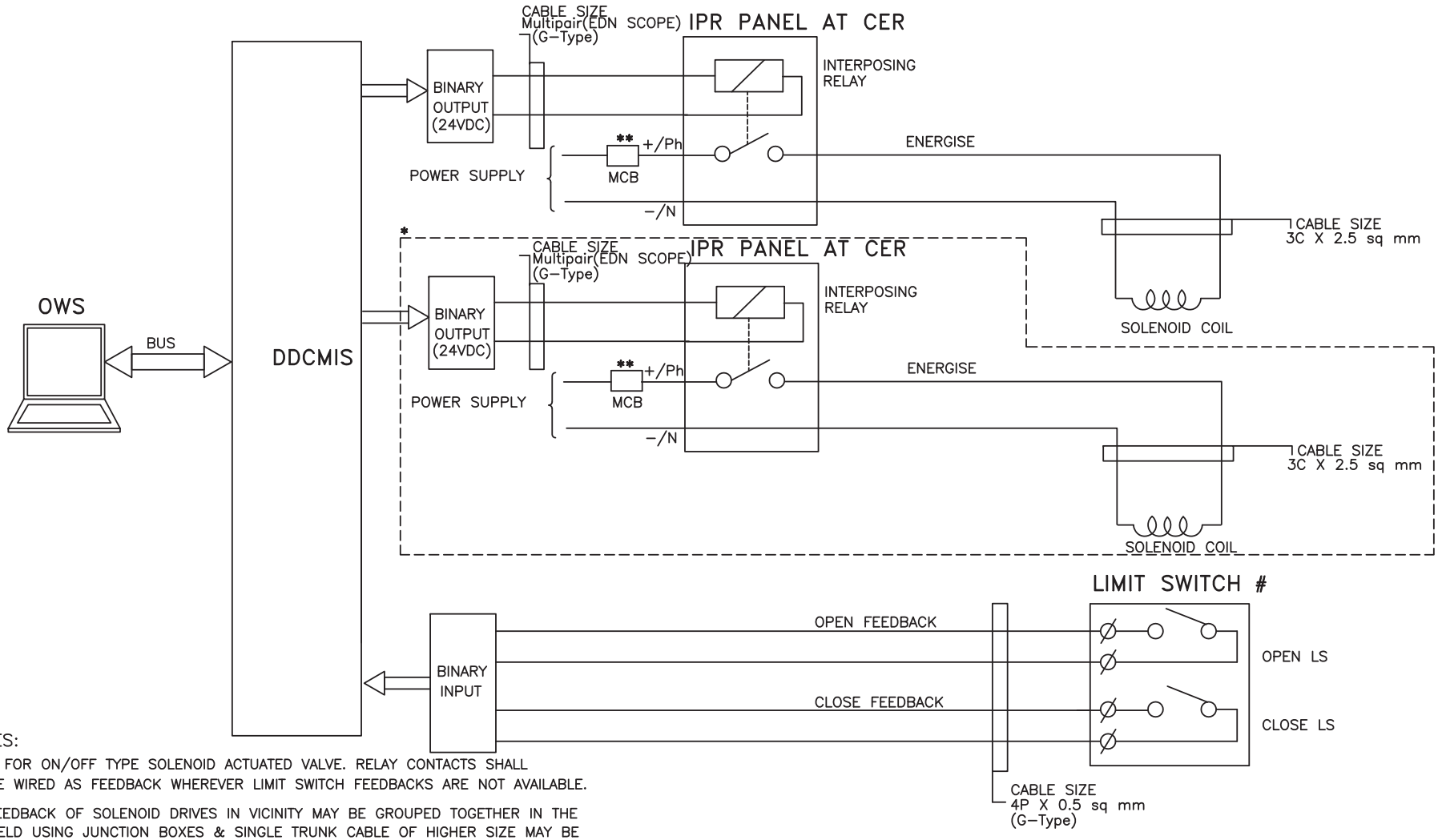


NOTE:

1. REDUNDANCY OF I/Os SHALL BE AS PER CONTRACT SPECIFICATION REQUIREMENT
2. SOFT INTERFACE TO BE PROVIDED FOR INTELLIGENT CONTROLLERS. 1

PROJECT: 1x800MW YAMUNANAGAR STPP	DRG.NO. PE–DM–510–145–H002
DDCMIS INTERFACE FOR UNIDIRECTIONAL LT DRIVE (CONTACTOR OPTD)	DATE 20.12.2024
	SHT 7 OF 10

DDCMIS INTERFACE FOR SOLENOID DRIVE
(24V DC / 240V AC UPS/220V DC)



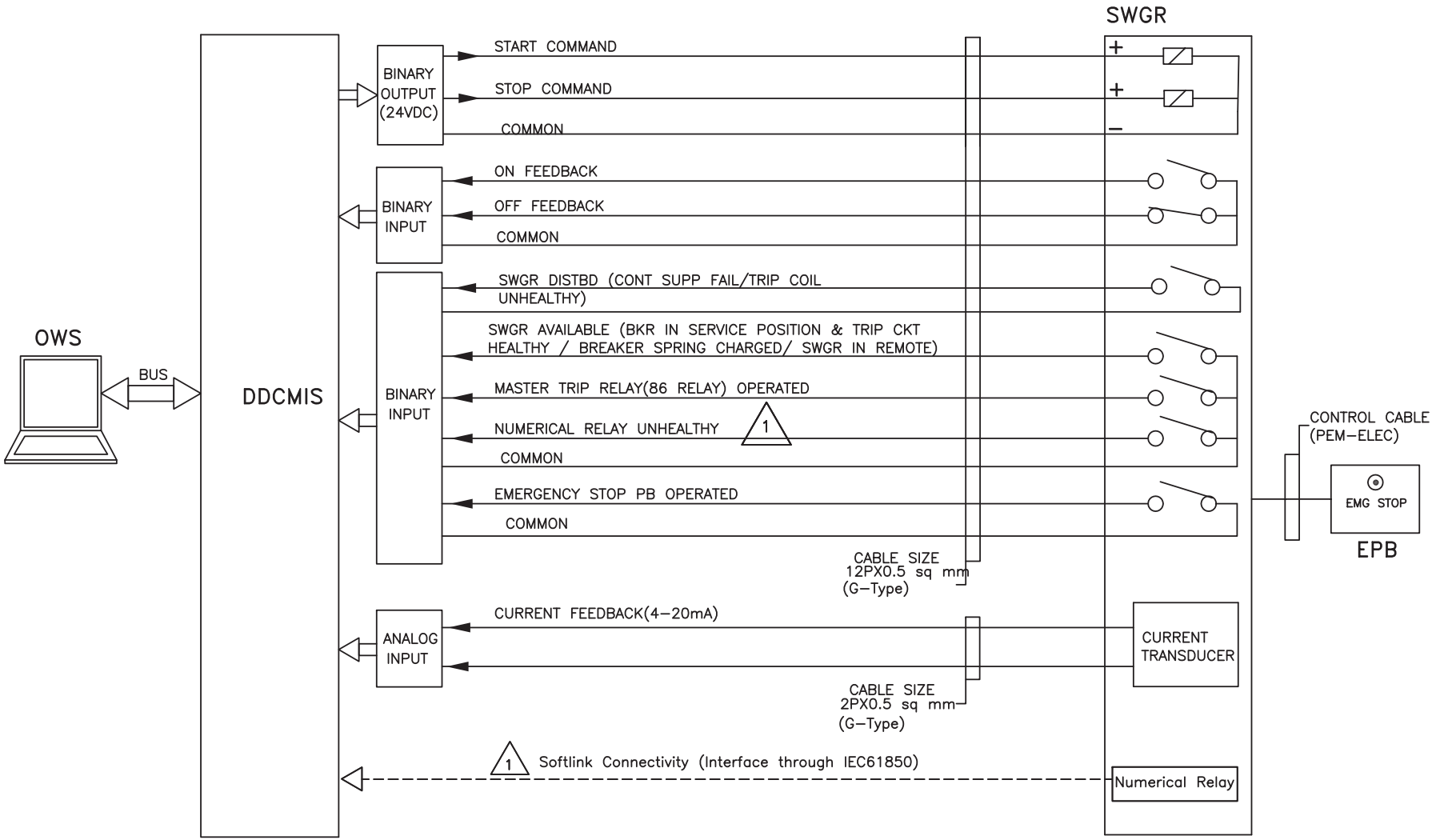
NOTES:

1. # FOR ON/OFF TYPE SOLENOID ACTUATED VALVE. RELAY CONTACTS SHALL BE WIRED AS FEEDBACK WHEREVER LIMIT SWITCH FEEDBACKS ARE NOT AVAILABLE.
2. FEEDBACK OF SOLENOID DRIVES IN VICINITY MAY BE GROUPED TOGETHER IN THE FIELD USING JUNCTION BOXES & SINGLE TRUNK CABLE OF HIGHER SIZE MAY BE USED TO CONNECT TO THE DDCMIS.
3. * TWO INDEPENDENT OUTPUTS FROM CONTROL SYSTEM SHALL BE PROVIDED TO PUSH-PULL TYPE VALVES, WITH DUAL COILED SOLENOID.
4. ** MCCB SHALL BE PROVIDED FOR EACH SOLENOID
5. REDUNDANCY OF IOs SHALL BE AS PER CONTRACT SPECIFICATION REQUIREMENT

1

PROJECT: 1x800MW YAMUNANAGAR STPP	DRG.NO. PE-DM-510-145-H002
DDCMIS INTERFACE FOR SOLENOID DRIVE	DATE 20.12.2024
	SHT 8 OF 10

DDCMIS INTERFACE FOR HT/LT UNIDIRECTIONAL DRIVES(BREAKER OPERATED)

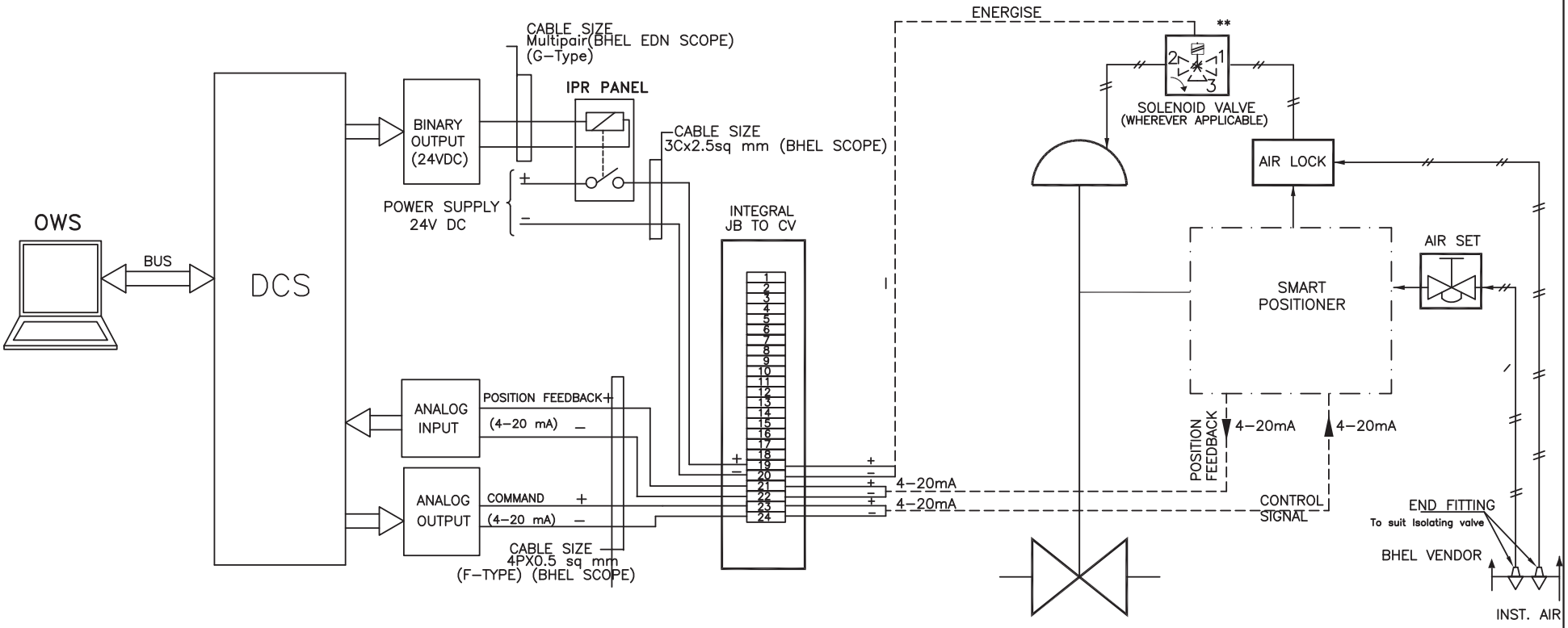


NOTE: 1

1. VIBRATION, WINDING & BEARING SIGNALS SHALL BE INTERFACED WITH DDCMIS & INCLUDED IN EDN DOCUMENT
2. REDUNDANCY OF IOs SHALL BE AS PER CONTRACT SPECIFICATION REQUIREMENT

PROJECT: 1x800MW YAMUNANAGAR STPP	DRG.NO. PE–DM–510–145–H002
DDCMIS INTERFACE FOR UNIDIRECTIONAL HT/LT DRIVE (BRKR OPERATED)	DATE 20.12.2024
	SHT 9 OF 10

DDCMIS INTERFACE FOR ANALOG DRIVE



NOTES:

1. CONTROL VALVES IN VICINITY MAY BE GROUPED TOGETHER IN THE FIELD USING IN CASE CONTROL VALVES ARE IN VICINITY, THEY WILL BE GROUPED. CABLE SIZES SHALL BE CONSIDERED ACCORDINGLY.
2. * APPLICABLE TO VALVES WHERE PROTECTION OPEN/CLOSE ACTION FOR CONTROL DEMAND OVERRIDING IS REQUIRED.
3. ** MCB SHALL BE PROVIDED FOR EACH SOLENOID ⚠1
4. $ APPLICABLE TO VALVES WHERE PROTECTION OPEN/CLOSE ACTION FOR CONTROL DEMAND OVERRIDING IS REQUIRED. ⚠1
5. REDUNDANCY OF IOs SHALL BE AS PER CONTRACT SPECIFICATION REQUIREMENT

PROJECT: 1x800MW YAMUNANAGAR STPP	DRG.NO. PE-DM-510-145-H002
TYPICAL HOOK-UP DIAGRAM ANALOG DRIVE (WITH SMART POSITIONER)	DATE 20.12.2024 SHT 10 OF 10

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. 114-04-0000, 0100 to 0113 and 114-18-0100), 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 8.1. For protection against sea environment, all impulse pipes, fittings etc shall be provided with durable epoxy coating with poly urethane finish.

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 8.1) 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 >/= 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 and Instrument air and Service air supply shall be provided for continuous and intermittent purging respectively for all transmitters of mill, dirty air flue gas applications. Purging scheme shall be as per drawing no. 114-04-0112.

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 copper/SS tubing conforming to ASTM B75 shall be used. It shall be at least 0.065 inch and shall be PVC coated. 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. The 1 inch Sub Header shall be of SS316.

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:

S. 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 280^{0}C
(ii)	1	15NB	< 40 bar (g) AND 280^{0}C.

S. No.	Quantity of root valves	Size of stub and root valve	Service Condition
Level Measurement			
(a)	**Level Gauge & Switch**		
(i)	2	25NB	≥ 40 bar(g) OR 280^{0}C
(ii)	1	25NB	< 40 bar(g) AND 280^{0}C
(b)	**Level transmitter (displacement type)**		
(i)	2	40NB	≥ 40 bar(g) OR 280^{0}C
(ii)	1	40NB	<40 bar(g) AND 280^{0}C
(c)	**Stand pipe for level measuring instrument**		
(i)	2	80 NB	≥ 40 bar(g) OR 280^{0}C
(ii)	1	80 NB	< 40 bar(g) AND 280^{0}C
Flow Measurement			
(i)	2	25NB	≥ 40 bar(g) OR 280^{0}C
(ii)	1	25NB	< 40 bar(g) AND 280^{0}C
Sampling system measurement (Steam and Water Service)			
(i)	2	25 NB	≥ 40 bar(g) OR 280^{0}C
(ii)	1	25 NB	< 40 bar(g) AND 280^{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.

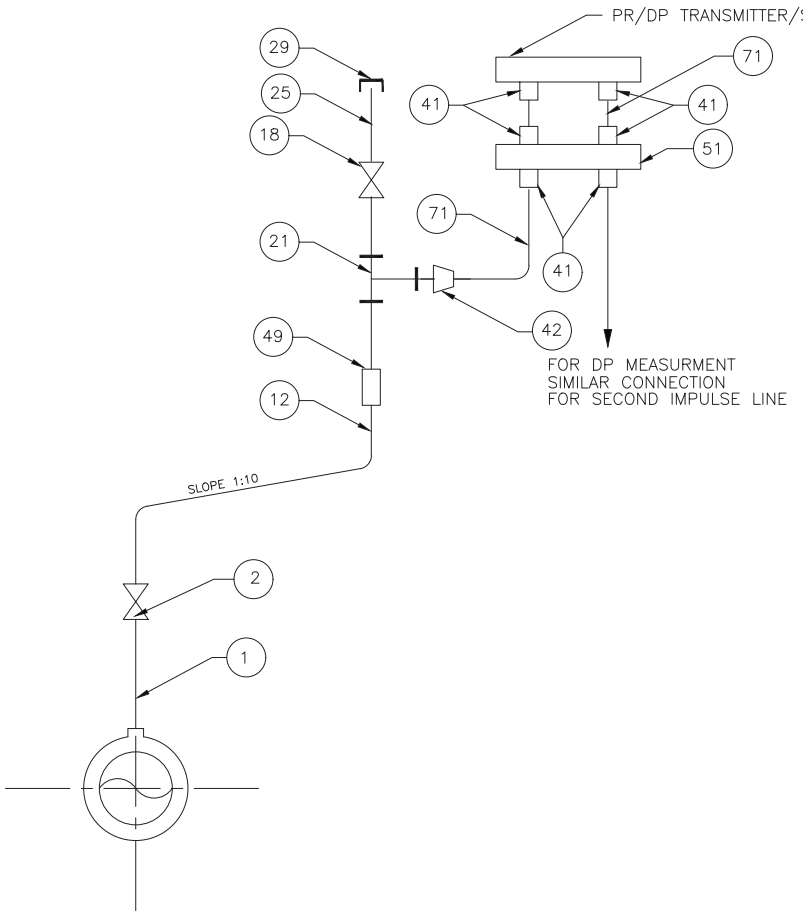
The bidder shall submit to the owner with his proposal a copy of his welding procedure specification together with proof of his compliance with the latest applicable welding ANSI code. Prior to any welding being performed the bidder shall submit the qualifications of the craftsmen who will perform the work.

Bidder shall provide not more than three variants for LIE/LIR with respect to max. no. transmitters mounted in each LIE/LIR.

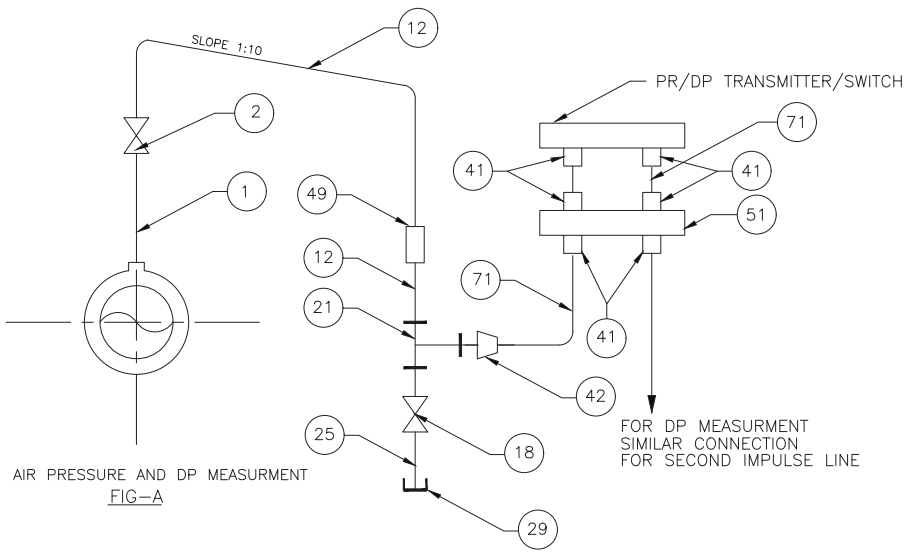
Each enclosure shall be provided with universal type 6/16 Amp. power receptacle, light fixture & LED lamps with wire guard and lighting switch etc. Lighting switches shall be door actuated & mounted inside the panel. Outlet box, switch box and device covers shall be of galvanized stamped steel. Light 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.

INSTRUMENT INSTALLATION DIAGRAM



AIR PRESSURE AND DP MEASURMENT
FIG–B



AIR PRESSURE AND DP MEASURMENT
FIG–A

TAG NO.	DESCRIPTION	A	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

REFERENCE DRAWINGS.

NOTES
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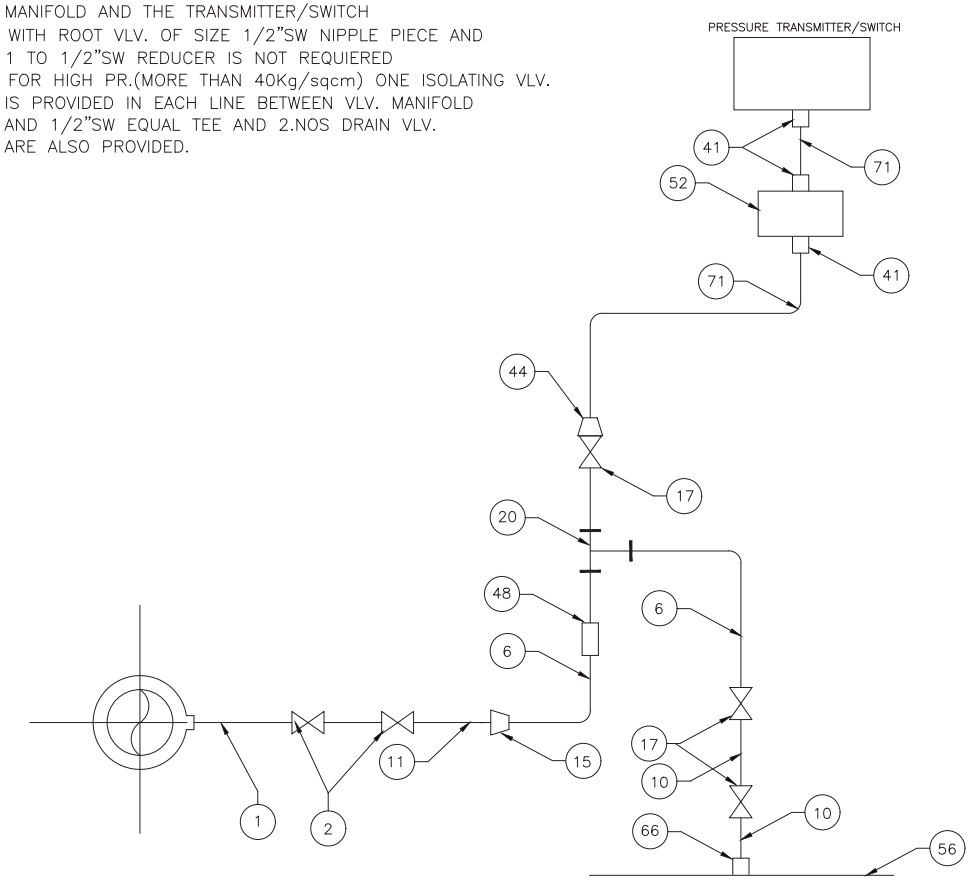
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CONSULTANT: DESEIN PRIVATE LIMITED
CONSULTING ENGINEERS, NEW DELHI, INDIA
PROJECT: 1x800 MW EXPANSION UNIT DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR, HARYANA
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Sheet No. 5 of 19

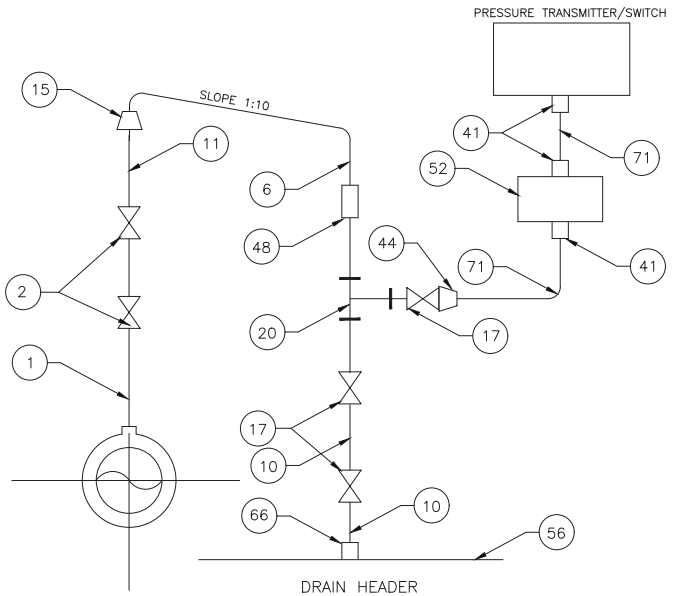
NOTE:–

1. FOR HIGH TEMP. SERVICE (MORE THAN °80C) A 'U'–TUBE / SYPHON (REF. DWG NO. IN–114–04–0100)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.



TRANSMITTER MOUNTED ABOVE INSTRUMENT SOURCE POINT

FIG–D



TRANSMITTER MOUNTED ABOVE INSTRUMENT SOURCE POINT

FIG–C

TAG NO.	DESCRIPTION	QTY. C	QTY. 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"OO 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

REFERENCE DRAWINGS.	NOTES	NOTICE
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CONSULTANT: DESEIN PRIVATE LIMITED CONSULTING ENGINEERS, NEW DELHI, INDIA

PROJECT: 1x800 MW EXPANSION UNIT DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR, HARYANA

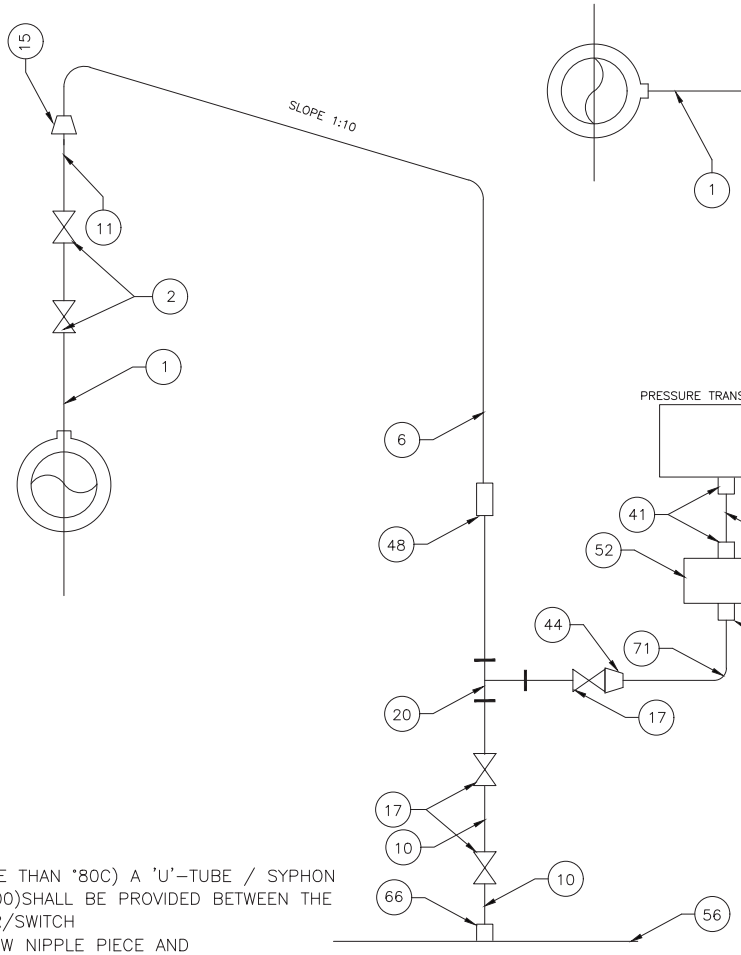
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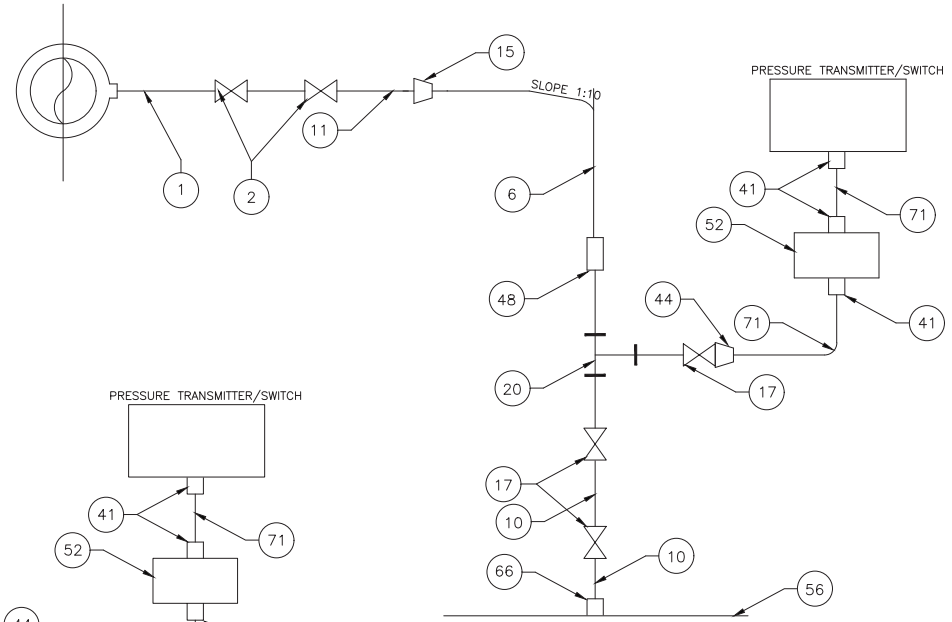
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TRANSMITTER MOUNTED BELOW
INSTRUMENT SOURCE POINT

FIG–A



TRANSMITTER MOUNTED BELOW
INSTRUMENT SOURCE POINT

FIG–B

NOTE:–

1. FOR HIGH TEMP. SERVICE (MORE THAN °80C) A 'U'–TUBE / SYPHON (REF. DWG NO. IN–114–04–0100)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.

BILL OF MATERIAL

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.	

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CONSULTANT: DESEIN PRIVATE LIMITED
CONSULTING ENGINEERS, NEW DELHI, INDIA

PROJECT: 1x800 MW EXPANSION UNIT DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR, HARYANA

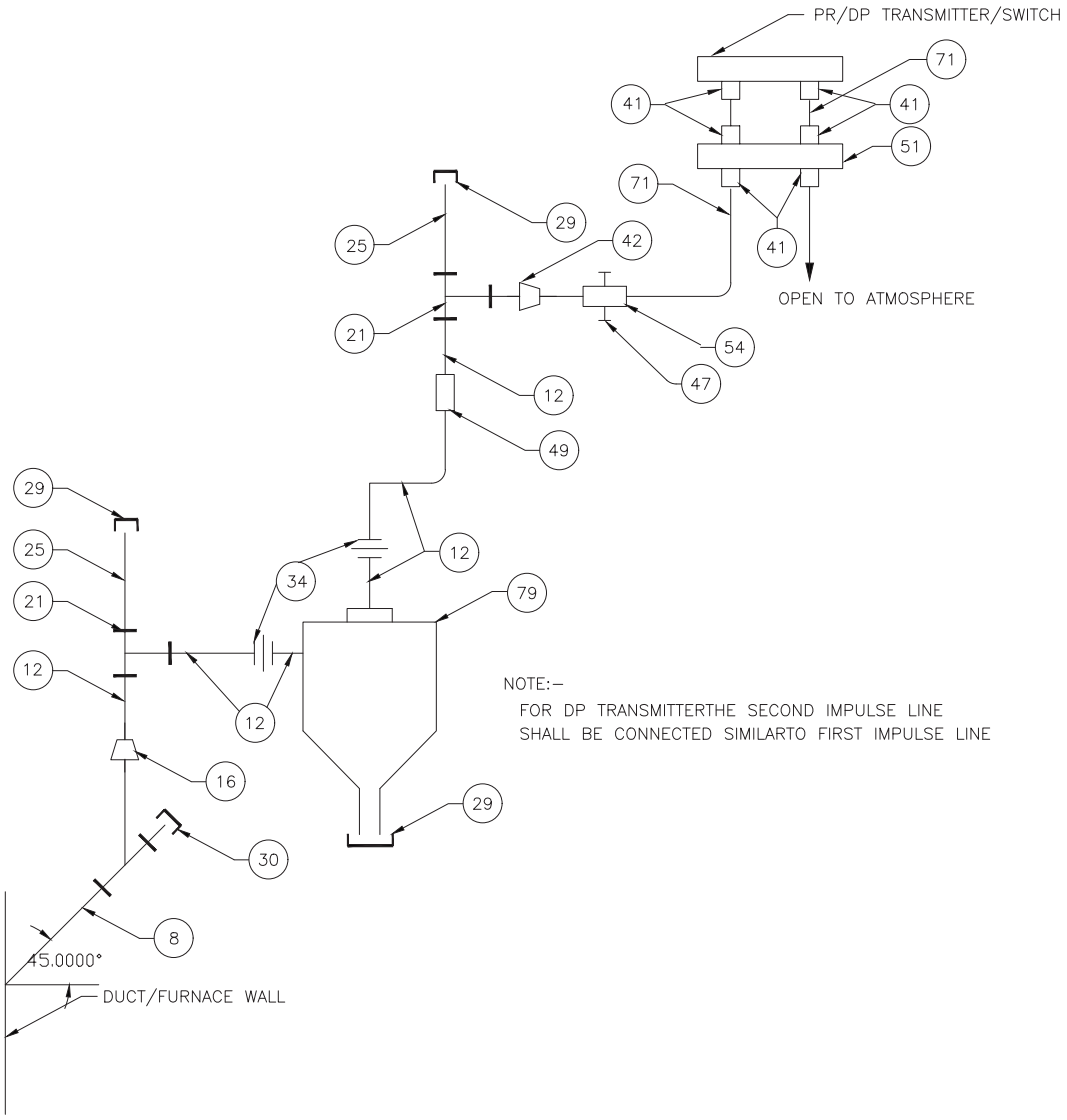
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NOTE:–
FOR DP TRANSMITTERTHE SECOND IMPULSE LINE
SHALL BE CONNECTED SIMILARTO FIRST IMPULSE LINE

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.

REFERENCE DRAWINGS.

NOTES

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CLIENT: HARYANA POWER GENERATION CORPORATION LTD.

CONSULTANT: DESEIN PRIVATE LIMITED
CONSULTING ENGINEERS, NEW DELHI, INDIA

PROJECT: 1x800 MW EXPANSION UNIT DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR, HARYANA

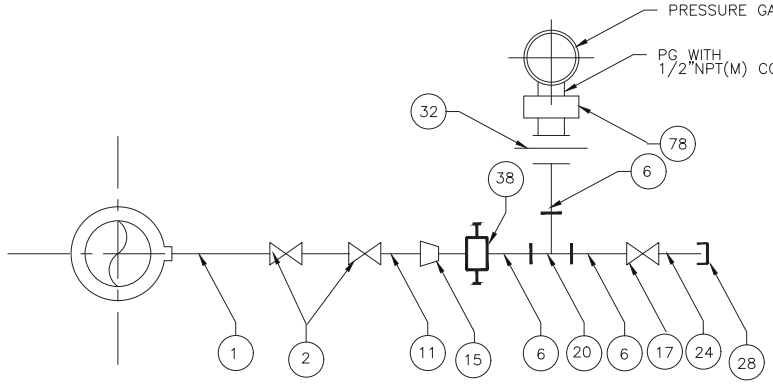
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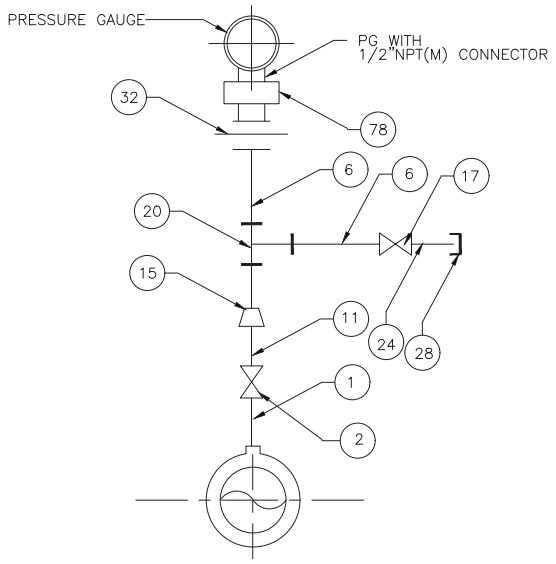
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STEAM/LIQUID SERVICE
FIG–A



AIR SERVICE
FIG–B

TAG NO.	DESCRIPTION	A	B
		QTY.	
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

REFERENCE DRAWINGS.

NOTES

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NOTICE

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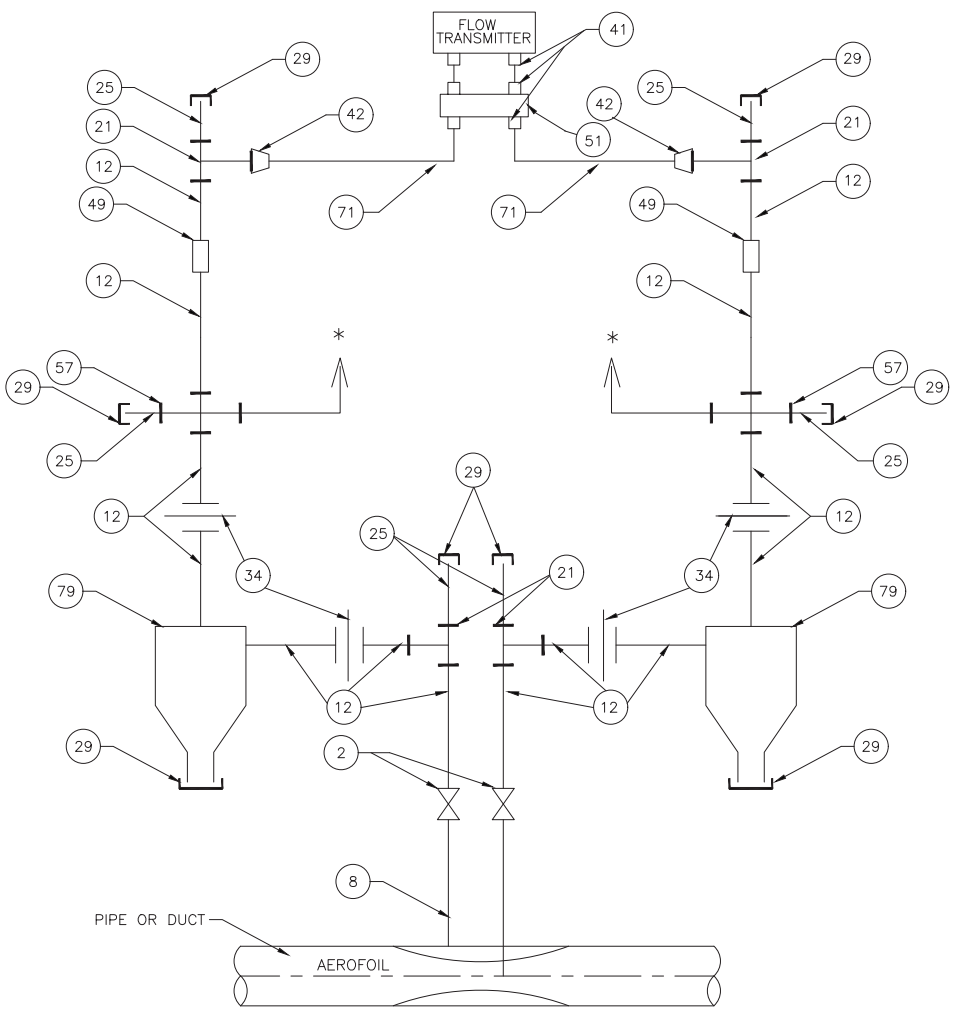
REVISIONS — APPROVED

CLIENT: HARYANA POWER GENERATION CORPORATION LTD.
CONSULTANT: DESEIN PRIVATE LIMITED, CONSULTING ENGINEERS, NEW DELHI, INDIA
PROJECT: 1x800 MW EXPANSION UNIT DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR, HARYANA
TITLE :- INST. DRAWING FOR LOCAL PRESSURE GAUGE

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JOB. NO. D–04041
DWG. NO. 114-04-0106 REV. 0
Sheet No. 9 of 19

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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

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NOTES

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CLIENT: HARYANA POWER GENERATION CORPORATION LTD.

CONSULTANT: DESEIN PRIVATE LIMITED
CONSULTING ENGINEERS, NEW DELHI, INDIA

PROJECT: 1x800 MW EXPANSION UNIT DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR, HARYANA

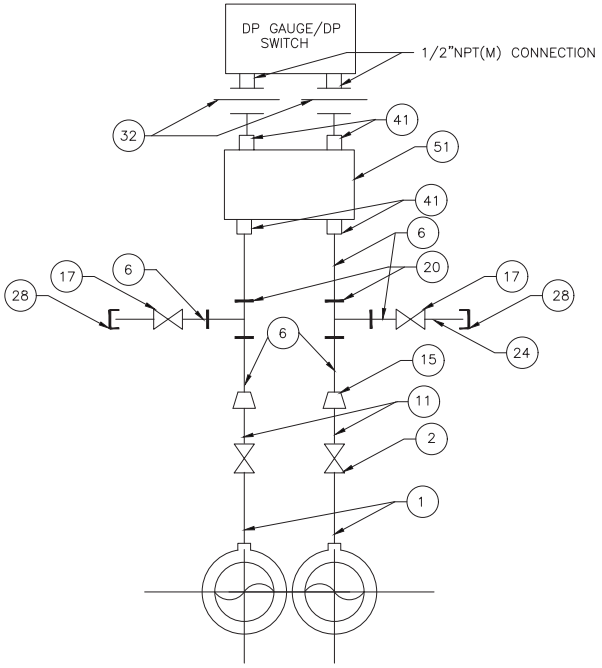
TITLE :- INST. DRAWING FOR FLOW TRANSMITTERS (AIR SERVICE)

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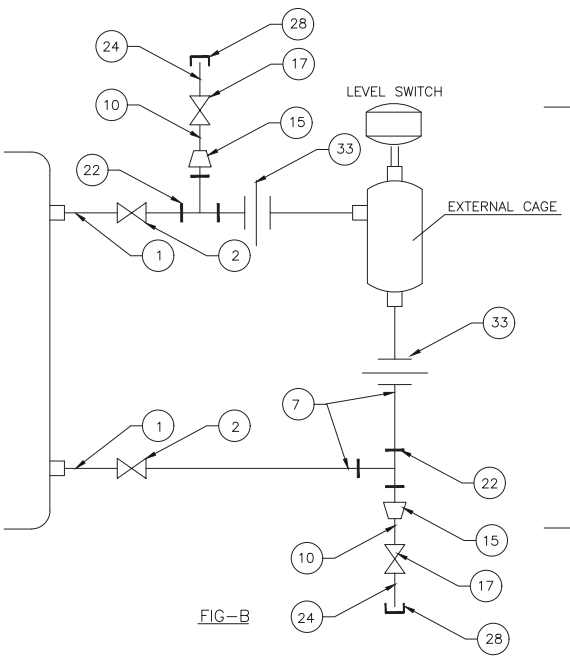
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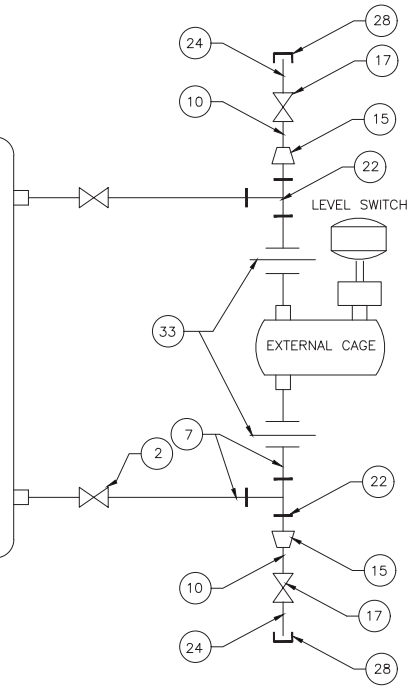
Sheet No. 10 of 19



FIG–A



FIG–B



FIG–C

TAG NO.	DESCRIPTION	A	B	C
		QTY.		
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

REFERENCE DRAWINGS.

NOTES

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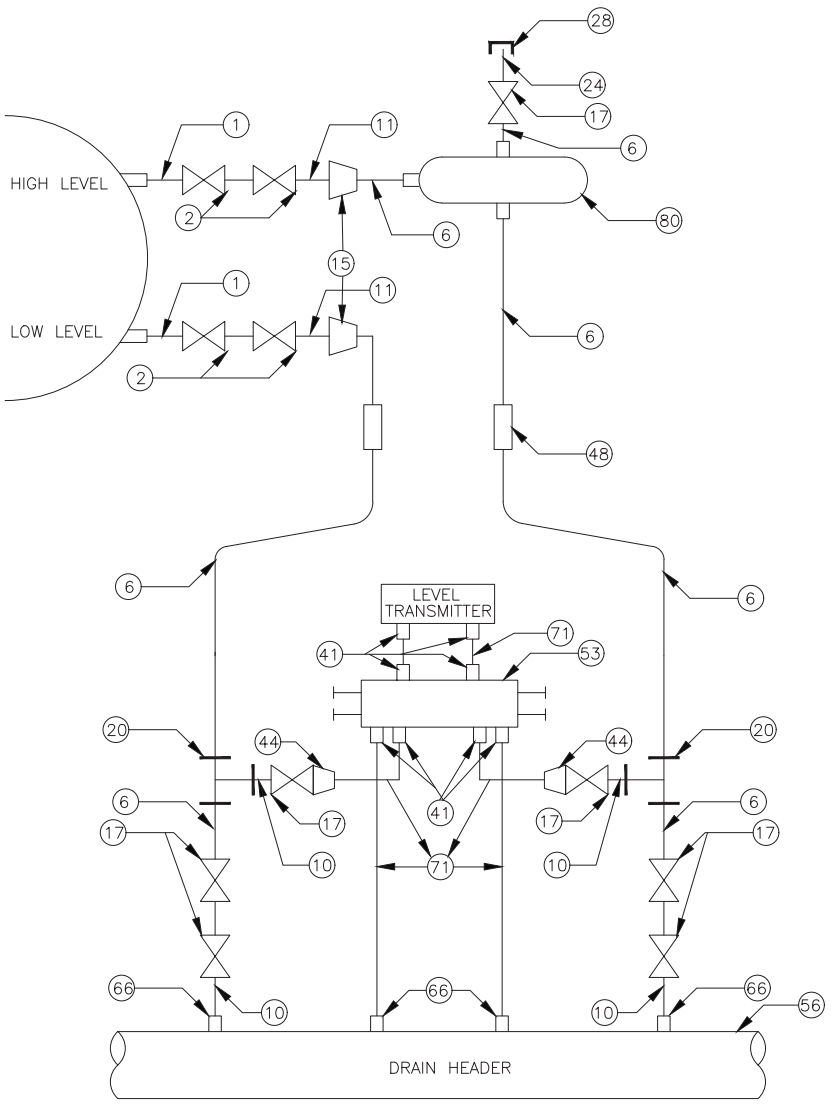
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CLIENT: HARYANA POWER GENERATION CORPORATION LTD.
CONSULTANT: DESEIN PRIVATE LIMITED, CONSULTING ENGINEERS, NEW DELHI, INDIA
PROJECT: 1x800 MW EXPANSION UNIT DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR, HARYANA
TITLE :– INST. DRAWING FOR DIFF. PRESS.SWITCH/GAUGE/ LEVEL SWITCHES

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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. DWG NO. 114-04-0100) 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

REFERENCE DRAWINGS.

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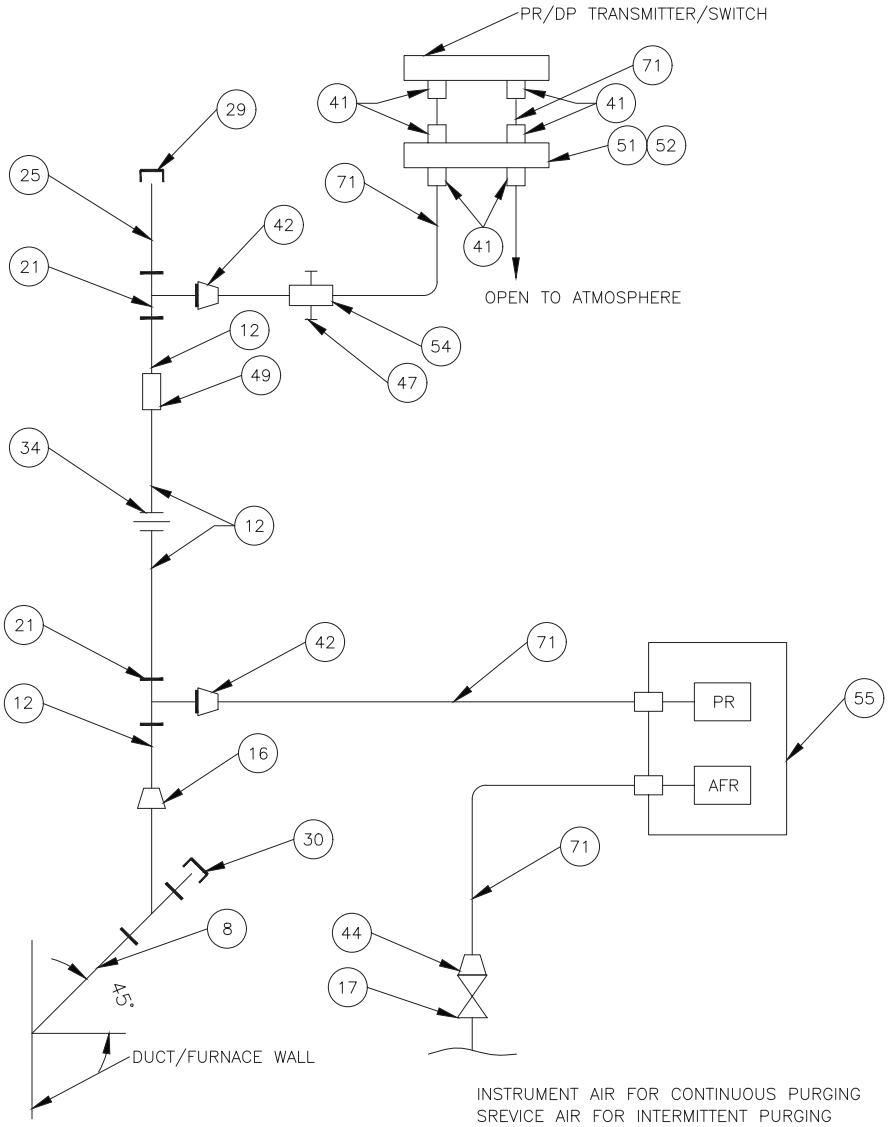
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CONSULTANT: DESEIN PRIVATE LIMITED, CONSULTING ENGINEERS, NEW DELHI, INDIA
PROJECT: 1x800 MW EXPANSION UNIT DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR, HARYANA
TITLE :- INST. DRAWING FOR LEVEL TRANSMITTERS

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DWG. NO. 114-04-0110 REV. 0
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INSTRUMENT AIR FOR CONTINUOUS PURGING
SREVICE AIR FOR INTERMITTENT 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

SR. No.	PARTY
11	
10	
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	3							
	2							
	1							
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CLIENT: HARYANA POWER GENERATION CORPORATION LTD.

CONSULTANT: DESEIN PRIVATE LIMITED
CONSULTING ENGINEERS, NEW DELHI, INDIA

PROJECT: 1x800 MW EXPANSION UNIT DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR, HARYANA

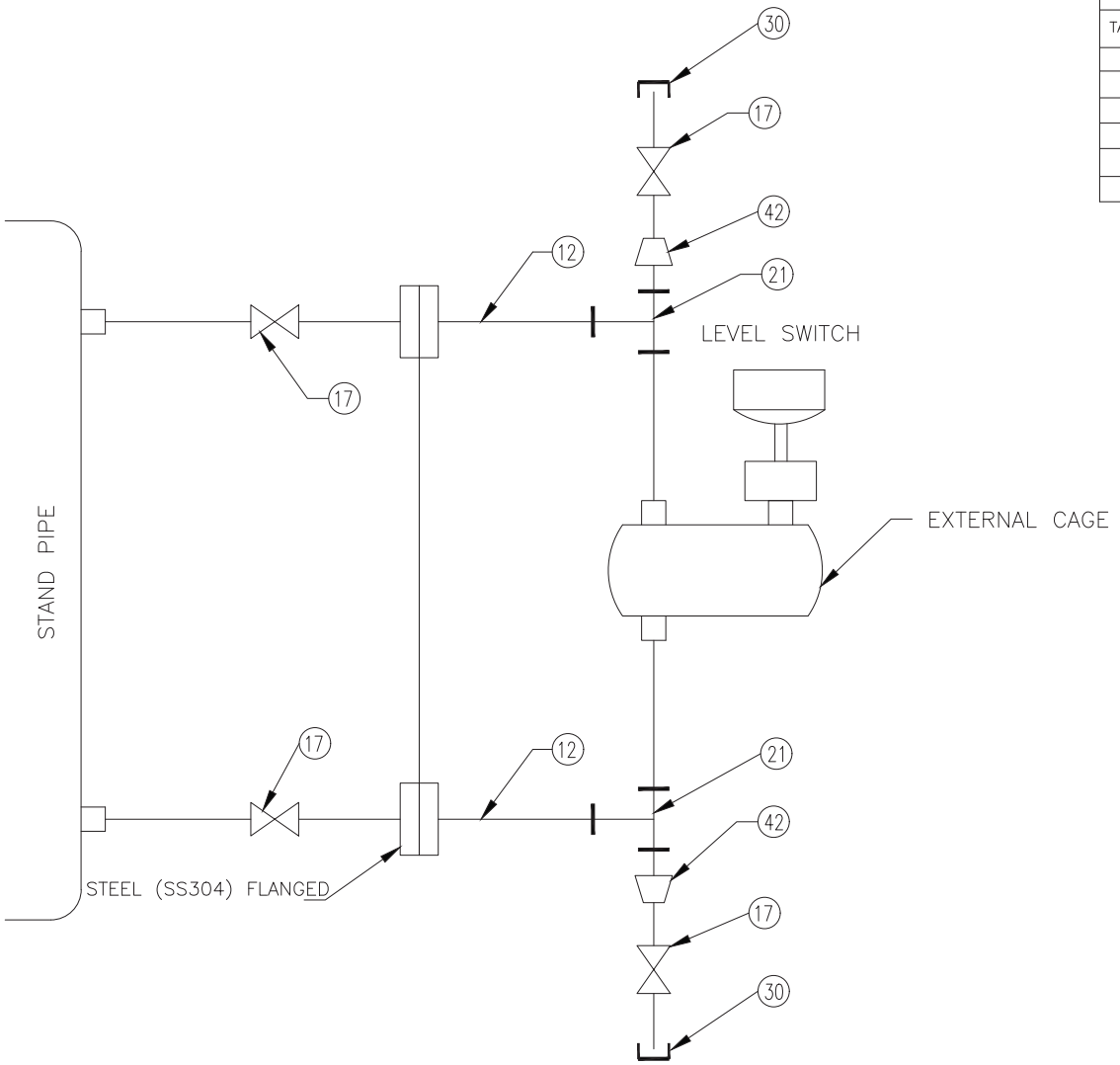
TITLE :- INST. DRAWING FOR AIR PURGING

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	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

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CONSULTANT: DESEIN PRIVATE LIMITED
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PROJECT: 1x800 MW EXPANSION UNIT DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR, HARYANA

TITLE :- INST. DRAWING FOR LEVEL SWITCH OPTION-1 WITH FLANGED CONNECTION

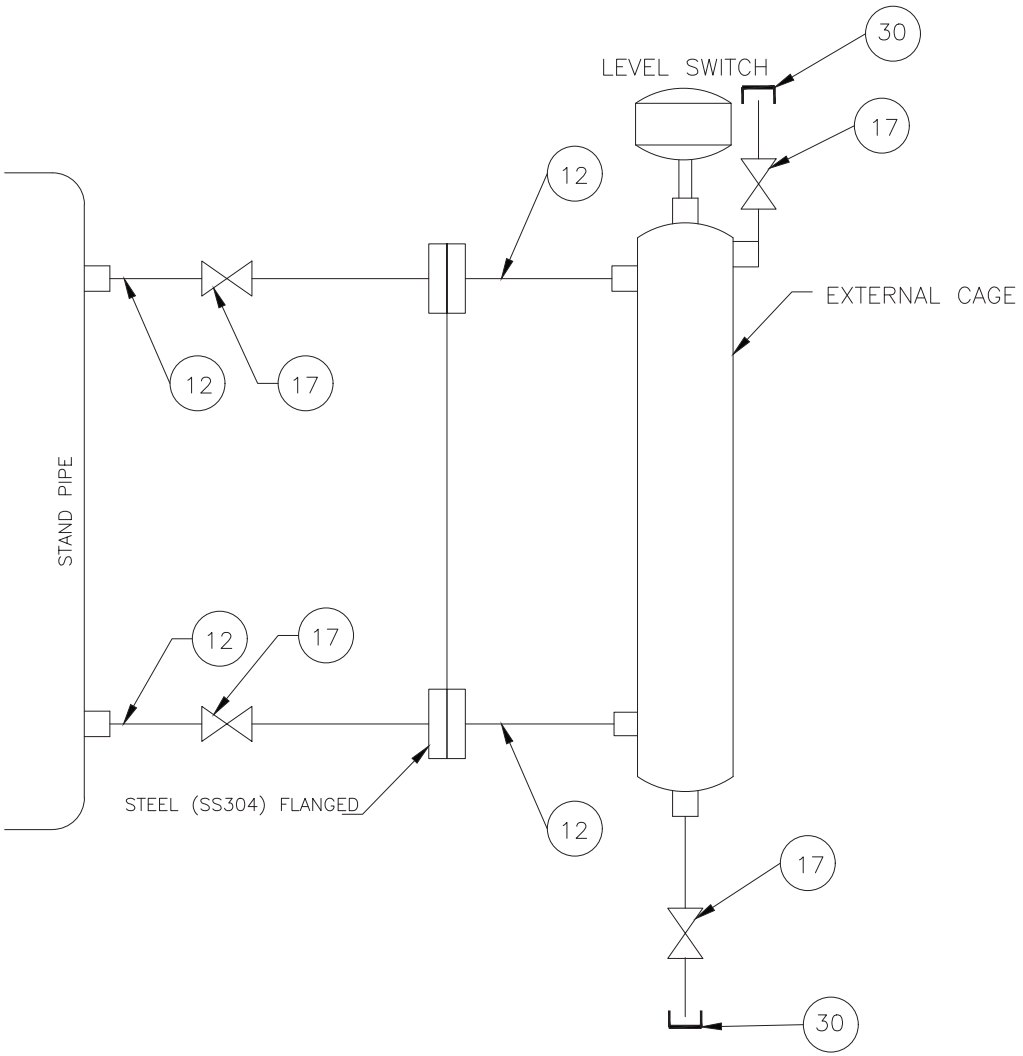
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	BILL OF MATERIAL	
TAG NO.	DESCRIPTION	QTY.
12	3/4" NPS SCH-80 CARBON STEEL PIPE	AS REQD.
17	1/2"/3/4"/1" SOCKET WELDED GLOBE VLV/ROOT VLV.	4
21	3/4" EQUAL TEE,CS	2
30	1/2" NPT (F) CS CAP	2
42	3/4"BW X 1/2"OD TUBE FITTING,SS-316	2



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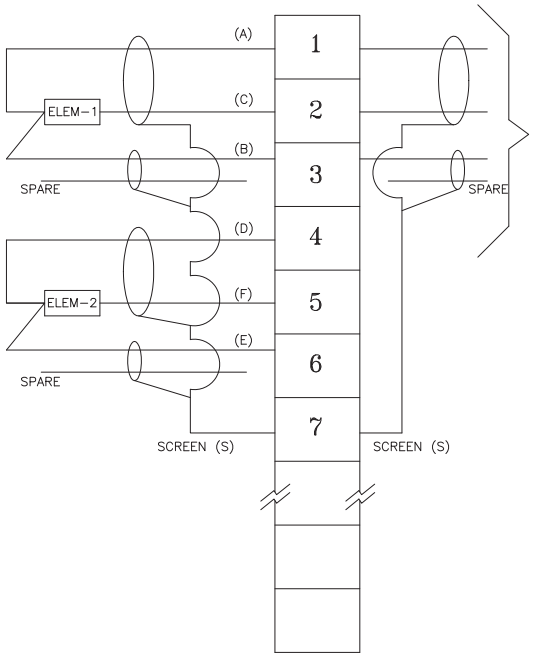
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CLIENT: HARYANA POWER GENERATION CORPORATION LTD.
CONSULTANT: DESEIN PRIVATE LIMITED, CONSULTING ENGINEERS, NEW DELHI, INDIA
PROJECT: 1x800 MW EXPANSION UNIT DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR, HARYANA
TITLE :- INST. DRAWING FOR LEVEL SWITCH OPTION-2 WITH FLANGED CONNECTION

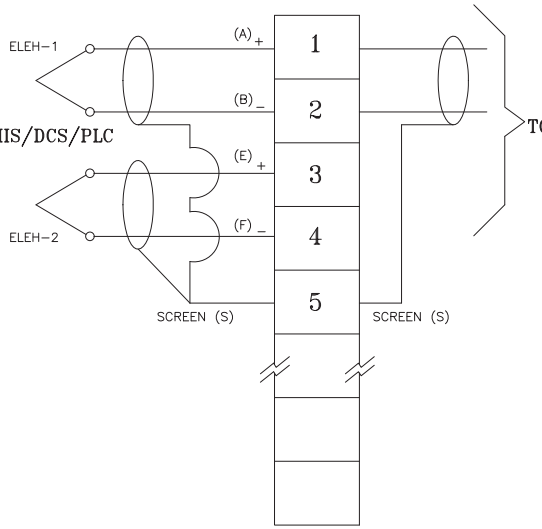
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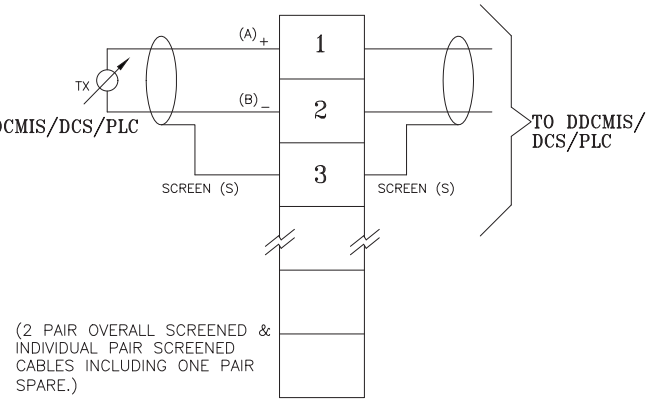
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TYPICAL CONNECTION DIAGRAM
FOR DUPLEX RTD



TYPICAL CONNECTION DIAGRAM
FOR DUPLEX THERMOCOUPLE



TYPICAL CONNECTION DIAGRAM
FOR TRANSMITTER

NOTE :–

1. SPLITTING OF CABLE MAY OCCUR WHEN TERMINALS REQD FOR AN ELEMENT ARE LOCATED ON SEPARATE STRIPS. HENCE, NO. OF TBS ON A TERMINAL STRIP SHALL BE ADDJUSTED TO PREVENT SPLITTING. 20% SPARE TB SHALL BE PROVIDED.
2. SCREENS SHALL BE EARTHED AT DDCMIS/DCS/PLC END ONLY. NO EARTHING OF SCREEN TO BE DONE AT JB/INSTRUMENT END
3. OVERALL SCREEN OF OUTGOING AND ASSOCIATED INCOMING CABLE TO BE CONNECTED TOGETHER ON A SPARE TERMINAL AND THEN CONNECTED TO EARTH AT DDCMIS/DCS/PLC END.
4. FOR SWITCH, BOTH CONTACTS (2 NO OR 2 NC AS PER PROCESS REQUIREMENT) SHALL BE CONNECTED TO JBs WITH 2 PAIR OVERALL SCREENED & INDIVIDUAL SCREENED PAIR CABLES.
5. FOR SWITCH, ALL CONTACTS (2 NO & 2 NC) SHALL BE CONNECTED TO JBs WITH 4 PAIR OVERALL SCREENED & INDIVIDUAL SCREENED PAIR CABLES AS PER NIT REQUIREMENTS.

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CONSULTANT: DESEIN PRIVATE LIMITED
CONSULTING ENGINEERS, NEW DELHI, INDIA

PROJECT: 1x800 MW EXPANSION UNIT DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR, HARYANA

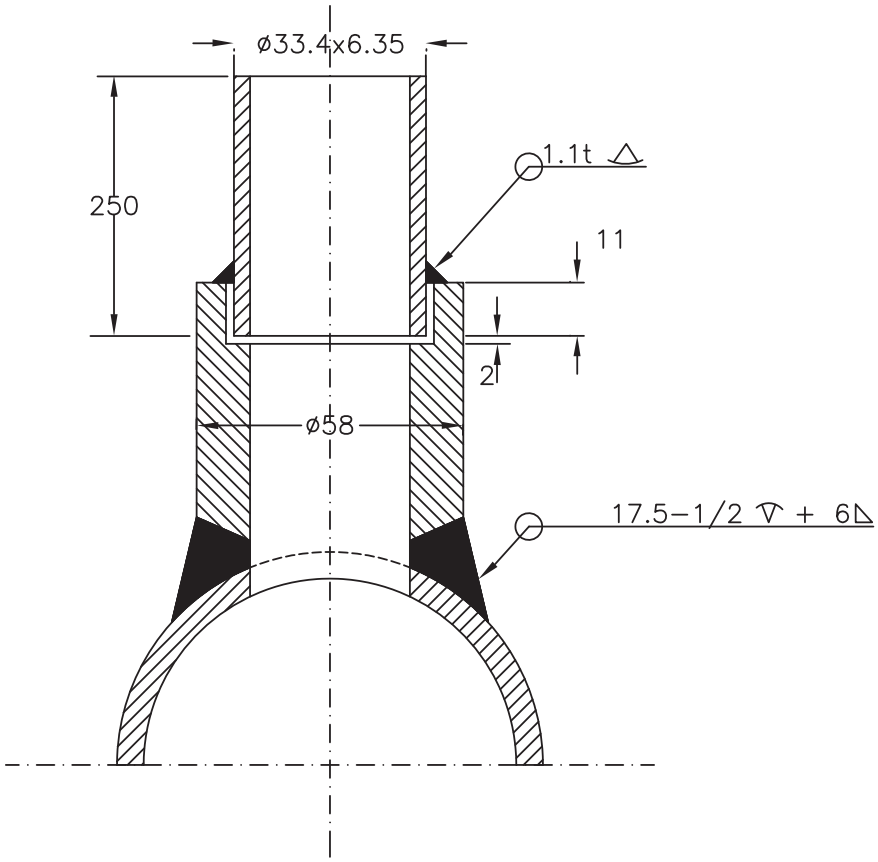
TITLE :– TYPICAL WIRING ARRANGEMENT IN JB

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INSTRUMENT STUB DETAIL



NOTE :

1. MATERIAL OF THE BOSS AND NIPPLE SHALL BE THE SAME AS THE PIPE INTO WHICH IT IS WELDED AND CONFORM TO ANSI B16.11.
2. THE LENGTH OF NIPPLE SHALL BE 250 MM.
3. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE INDICATED
4. EDGE HOLE MUST BE CLEAN AND SQUARE OR ROUNDED SLIGHTLY (1/64" RADIUS) FREE FROM BURRS, WIRE EDGES OR OTHER IRREGULARITIES
5. STUB LENGTH SHALL BE 64mm UPTO 200Nb PIPE, 45mm ABOVE 200Nb PIPE SIZE.

बीएचईएल BHEL

TITLE :

INSTRUMENT STUB DETAILS FOR PRESSURE MEASUREMENT

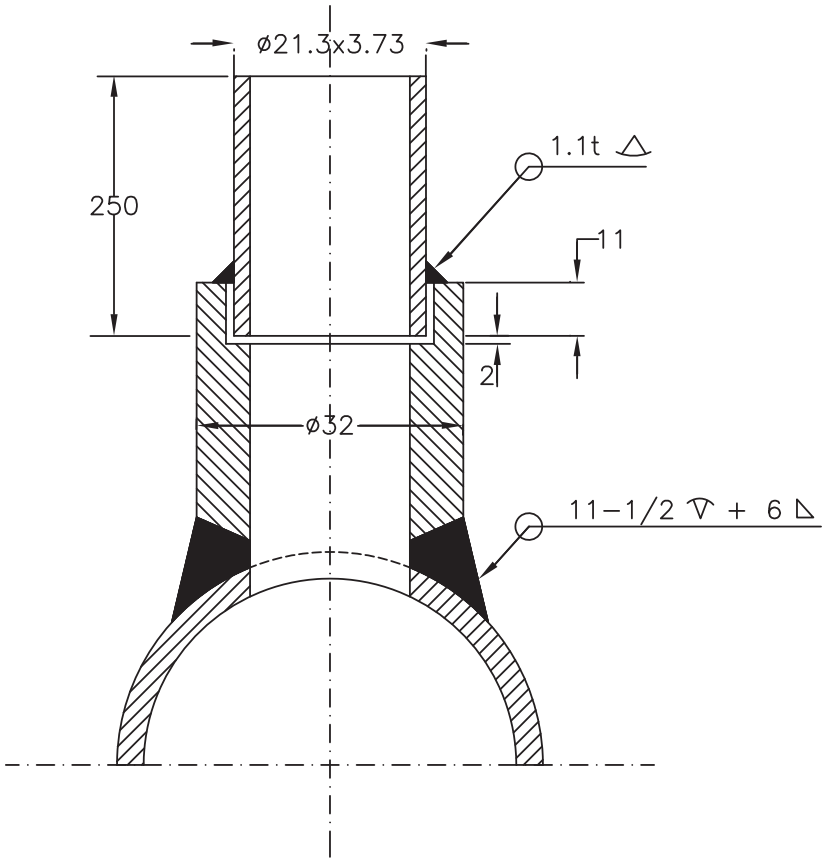
(APPLICABLE FOR TEMP< 500 DegC,PRESS > 40 Kg/cm2 AND CLASS 6000#)

DRG. NO.

PE–DG–510–145–H101

REV. 00

SH. 03 OF 08 SHS.

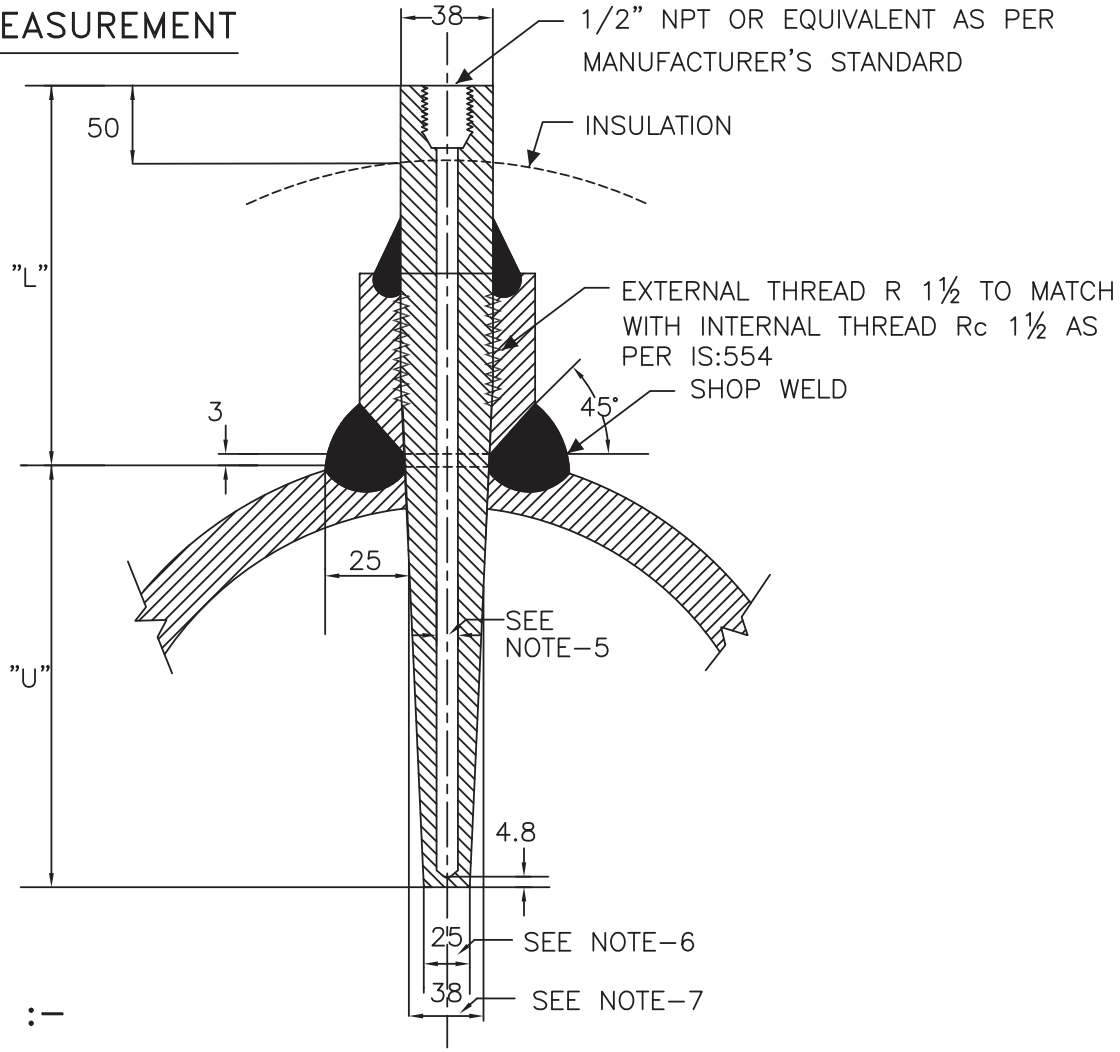


NOTE :

1. MATERIAL OF THE BOSS AND NIPPLE SHALL BE THE SAME AS THE PIPE INTO WHICH IT IS WELDED AND CONFORM TO ANSI B16.11.
2. THE LENGTH OF NIPPLE SHALL BE 250 MM.
3. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE INDICATED
4. EDGE HOLE MUST BE CLEAN AND SQUARE OR ROUNDED SLIGHTLY (1/64" RADIUS) FREE FROM BURRS, WIRE EDGES OR OTHER IRREGULARITIES
5. STUB LENGTH SHALL BE 64mm UPTO 200Nb PIPE, 45mm ABOVE 200Nb PIPE SIZE.

BHEL	TITLE : INSTRUMENT STUB DETAILS FOR PRESSURE MEASUREMENT (SYSTEM PRESS UPTO 40Kg/Cm2, TEMP< 400 Deg C)	DRG. NO. PE–DG–510–145–H101 REV. 00 SH. 04 OF 08 SHS.

TEMP. MEASUREMENT



NOTES :–

1. THIS TYPE OF TEMPERATURE BOSS SHALL BE USED FOR THE PROCESS PRESS EQUAL/ ABOVE 40 KG/CM2(g) AND FOR PROCESS TEMP.>400 DEG C EVEN IF THE PROCESS PRESSURE IS LESS THAN 40 KG/CM2(g).
2. THE MATERIAL OF THE BOSS SHALL BE SIMILAR TO PIPING MATERIAL.
3. MATERIAL OF THE THERMOWELL SHALL BE OF 316SS.
4. THERMOWELL SHALL BE DRILLED BAR STOCK TYPE.
5. INTERNAL BORE OF THE THERMOWELL SHOULD BE SELECTED BASED ON THE NORMAL SIZE OF THE SENSING ELEMENT AS PER ASME PTC–19.3.
6. THE BOTTOM DIAMETER OF THE THERMOWELL TYPICALLY SHOWN HERE SHALL BE SUBJECT TO VARIATION BASED ON THE INTERNAL BORE OF THERMOWELL AND THICKNESS OF THERMOWELL MATERIAL TO WITHSTAND THE PROCESS PRESS AND TEMP AS PER ASME PTC–19.3.
7. THERMOWELL SHALL BE SUITABLE TO MATCH THE STUB DIMENSIONS AS PER Rc 1½.
8. THE 'U' & 'L' DIMENSIONS SHALL BE SELECTED BASED ON PARTICULAR APPLICATION.
9. ORIENTATION OF STUB ON VERTICAL/ HORIZONTAL PIPES SHALL BE 90° TO THE CENTRE LINE OF THE PIPES, FOR PIPE SIZE LARGER THAN 4". HEIGHT OF STUB SHALL BE 64mm FOR PIPE OD < 200Nb AND 45mm FOR PIPE OD ≤ 200Nb.
10. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE INDICATED.

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TITLE :

INSTRUMENT STUB DETAILS (TEMP)
(APPLICABLE FOR PIPE SIZE ABOVE 4")

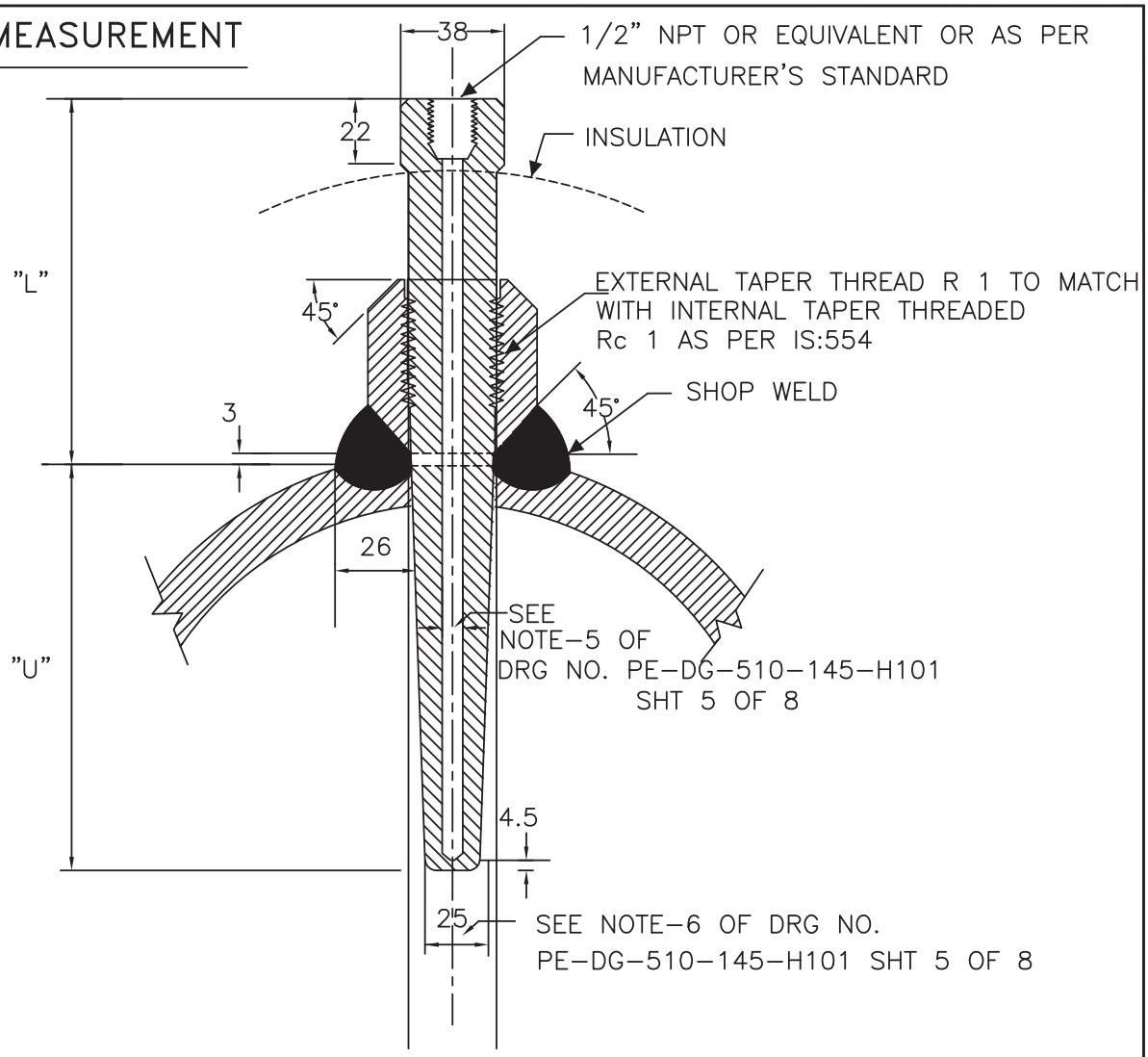
[DESIGN PRESS EQUAL/> 40 Kg/Cm2 (g)
DESIGN PRESS < 40 Kg/Cm2 (g), TEMP.EQUAL/>400 DEG C]

DRG. NO. PE–DG–510–145–H101

REV. 00

SH. 05 OF 08 SHS.

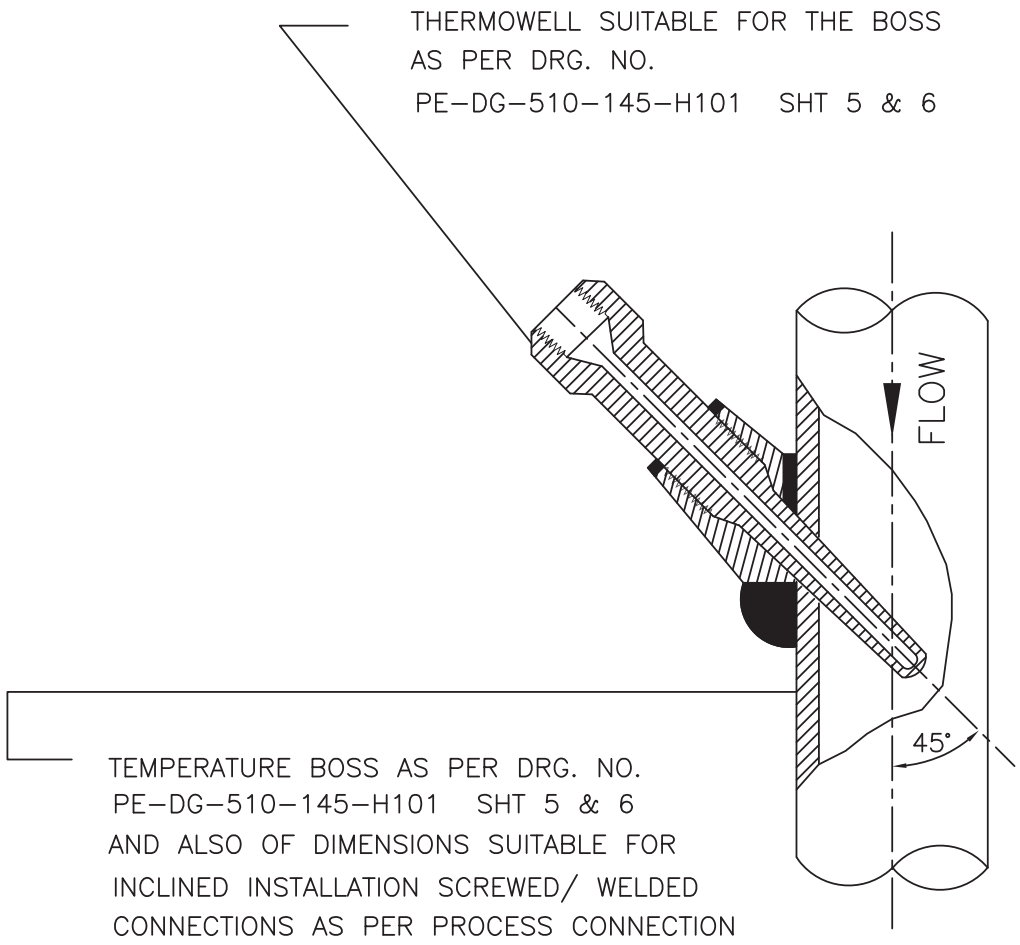
TEMP. MEASUREMENT



NOTES :–

1. THIS TYPE OF TEMPERATURE BOSS IS APPLICABLE FOR THE PROCESS PRESS/ TEMP. BELOW 40 KG/CM2(g)/400°C.
2. SEE NOTES–2 TO 9 IN SHT. 5 OF 8 OF THIS DRG.
3. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE INDICATED.

BHEL	TITLE : INST. STUB DETAILS (TEMP) (APPLICABLE FOR PIPE SIZE ABOVE 4") [DESIGN PRESS < 40 Kg/Cm2 (g),TEMP < 400 C]	DRG. NO. PE–DG–510–145–H101 REV. 00 SH. 06 OF 08 SHS.



NOTES :–

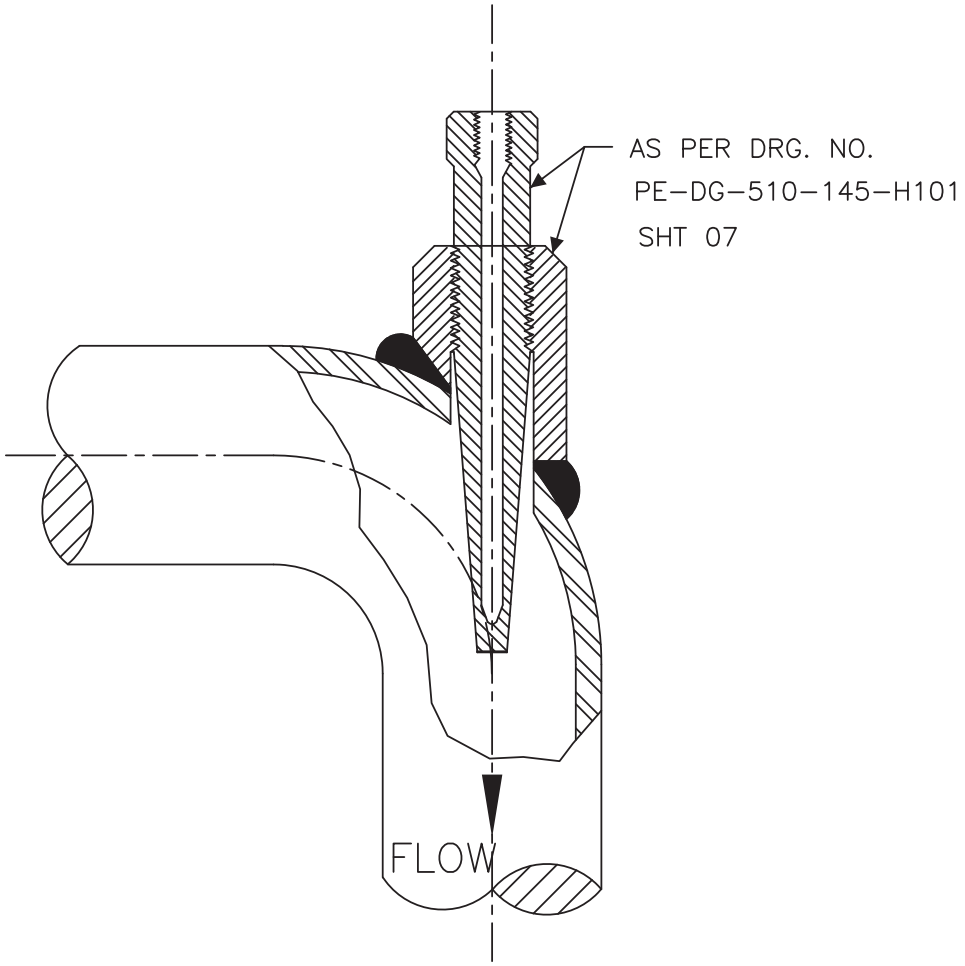
1. INCLINED INSTALLATION OF THERMOWELL SHALL BE APPLICABLE FOR 4" AND SMALLER LINE SIZE BUT LIMITED TO MIN. 3" LINE SIZE.
2. FOR 2" AND SMALLER LINE SIZE NECESSARY EXPANDER OF 3" SIZE OF MAIN PIPING SPECIFICATION SHALL BE USED.
3. THIS TYPE OF INSTALLATION IS APPLICABLE FOR HORIZONTAL AND VERTICAL PIPE SECTION.
4. FOR STEAM SERVICES EXPANDER SECTION MAY BE USED ONLY IN VERTICAL RUN.
5. THE EXPANDER SECTION SHALL BE OF ADEQUATE LENGTH (ATLEAST 3–4 TIMES DIA OF THE MAIN PROCESS PIPE AT BOTH SIDE OF INSTALLED THERMOWELL).

बीएचईएल BHEL

TITLE :

THERMOWELL INSTALLATION

DRG. NO.
PE–DG–510–145–H101
REV. 00
SH. 07 OF 08 SHS.



NOTES :–

1. FLOW INSTALLATION OF THERMOWELL SHALL BE APPLICABLE FOR 4" AND SMALLER LINE SIZE BUT LIMITED TO MINIMUM 3" LINE SIZE. THIS DETAIL IS APPLICABLE FOR THERMOWELL INSTALLATION IN BEND PIPES.
2. FOR 2" AND SMALLER LINE SIZE NECESSARY EXPANDER OF ELBOW FORM (AS SHOWN) OF 3" SIZE SHALL BE USED.
3. ELBOW EXPANDER SECTION IN HORIZONTAL PLANE TO BE USED FOR LIQUID SERVICE. FOR STEAM SERVICES EXPANDER SECTION TO BE USED IN VERTICAL PLANE.

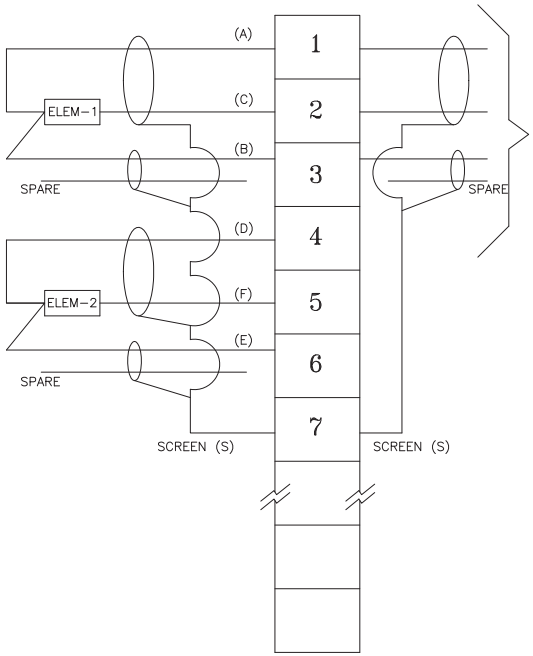
बीएचईएल BHEL

TITLE :

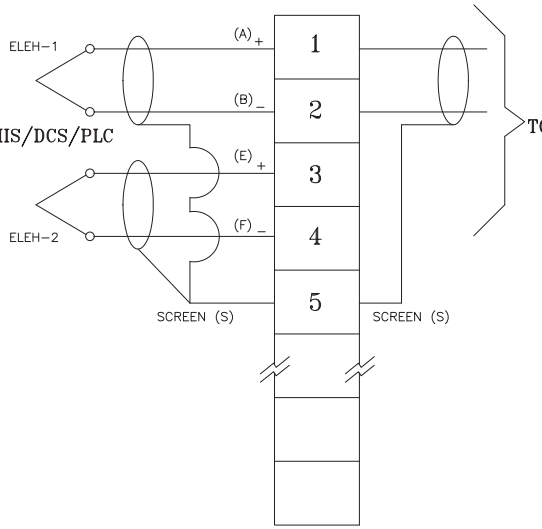
THERMOWELL INSTALLATION
(IN BEND PIPES)

DRG. NO.
PE–DG–510–145–H101
REV. 00
SH. 08 OF 08 SHS.

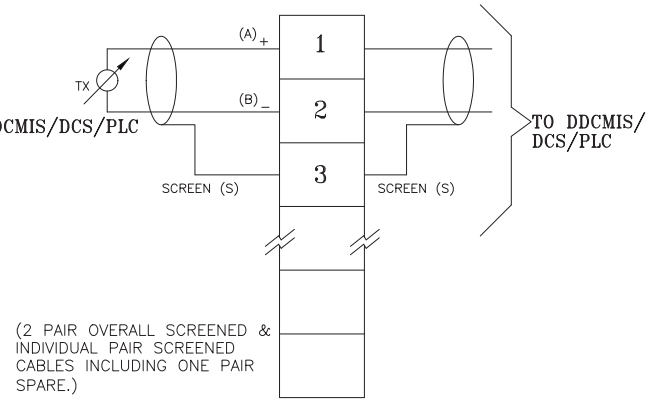
INSTRUMENT WIRING DIAGRAM



TYPICAL CONNECTION DIAGRAM
FOR DUPLEX RTD



TYPICAL CONNECTION DIAGRAM
FOR DUPLEX THERMOCOUPLE



TYPICAL CONNECTION DIAGRAM
FOR TRANSMITTER

NOTE :–

1. SPLITTING OF CABLE MAY OCCUR WHEN TERMINALS REQD FOR AN ELEMENT ARE LOCATED ON SEPARATE STRIPS. HENCE, NO. OF TBS ON A TERMINAL STRIP SHALL BE ADDJUSTED TO PREVENT SPLITTING. 20% SPARE TB SHALL BE PROVIDED.
2. SCREENS SHALL BE EARTHED AT DDCMIS/DCS/PLC END ONLY. NO EARTHING OF SCREEN TO BE DONE AT JB/INSTRUMENT END
3. OVERALL SCREEN OF OUTGOING AND ASSOCIATED INCOMING CABLE TO BE CONNECTED TOGETHER ON A SPARE TERMINAL AND THEN CONNECTED TO EARTH AT DDCMIS/DCS/PLC END.
4. FOR SWITCH, BOTH CONTACTS (2 NO OR 2 NC AS PER PROCESS REQUIREMENT) SHALL BE CONNECTED TO JBs WITH 2 PAIR OVERALL SCREENED & INDIVIDUAL SCREENED PAIR CABLES.
5. FOR SWITCH, ALL CONTACTS (2 NO & 2 NC) SHALL BE CONNECTED TO JBs WITH 4 PAIR OVERALL SCREENED & INDIVIDUAL SCREENED PAIR CABLES AS PER NIT REQUIREMENTS.

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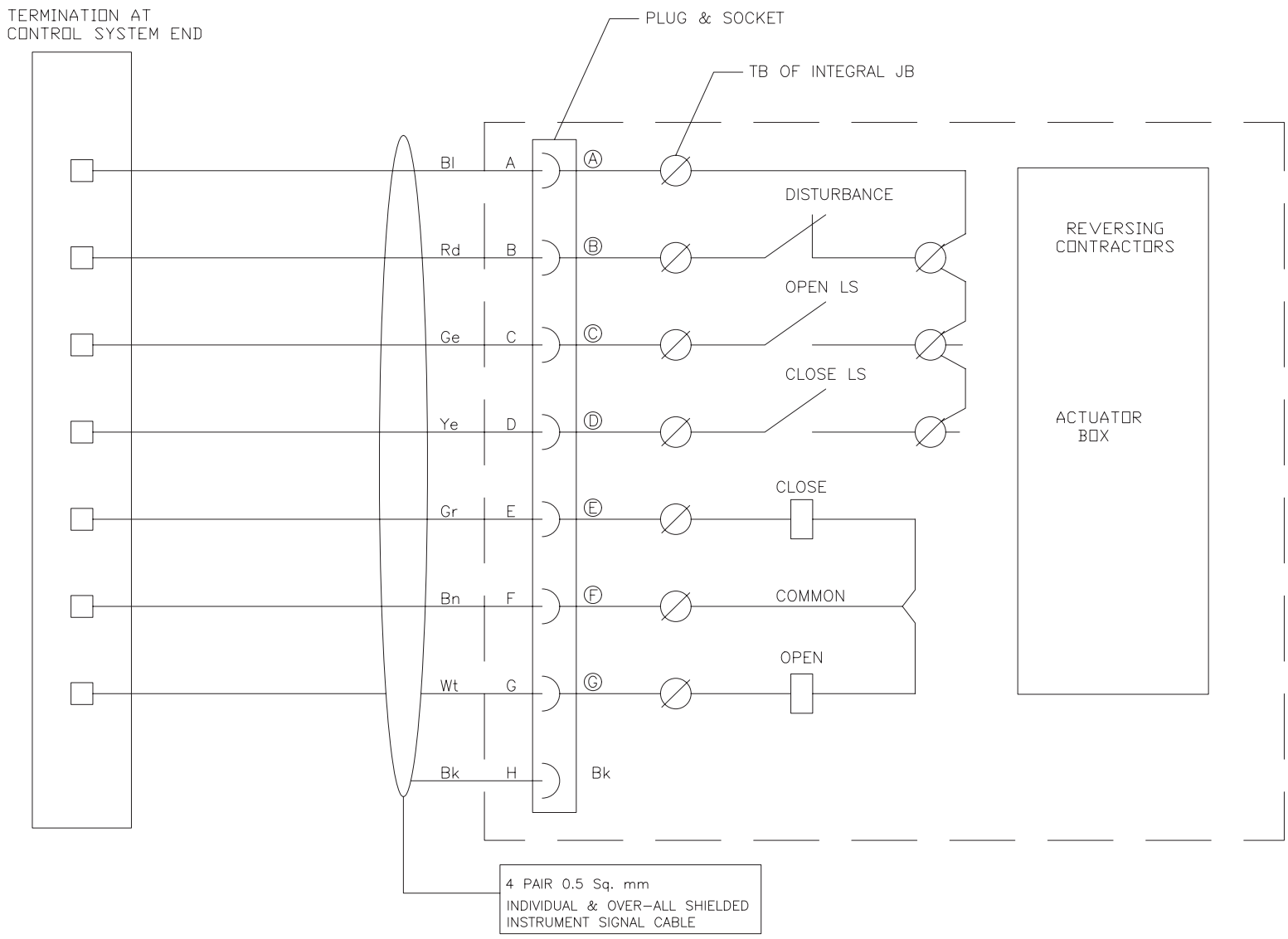
PROJECT: 1x800 MW EXPANSION UNIT DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR, HARYANA

TITLE :– TYPICAL WIRING ARRANGEMENT IN JB

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PROJECT: 1x800 MW EXPANSION UNIT DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR, HARYANA

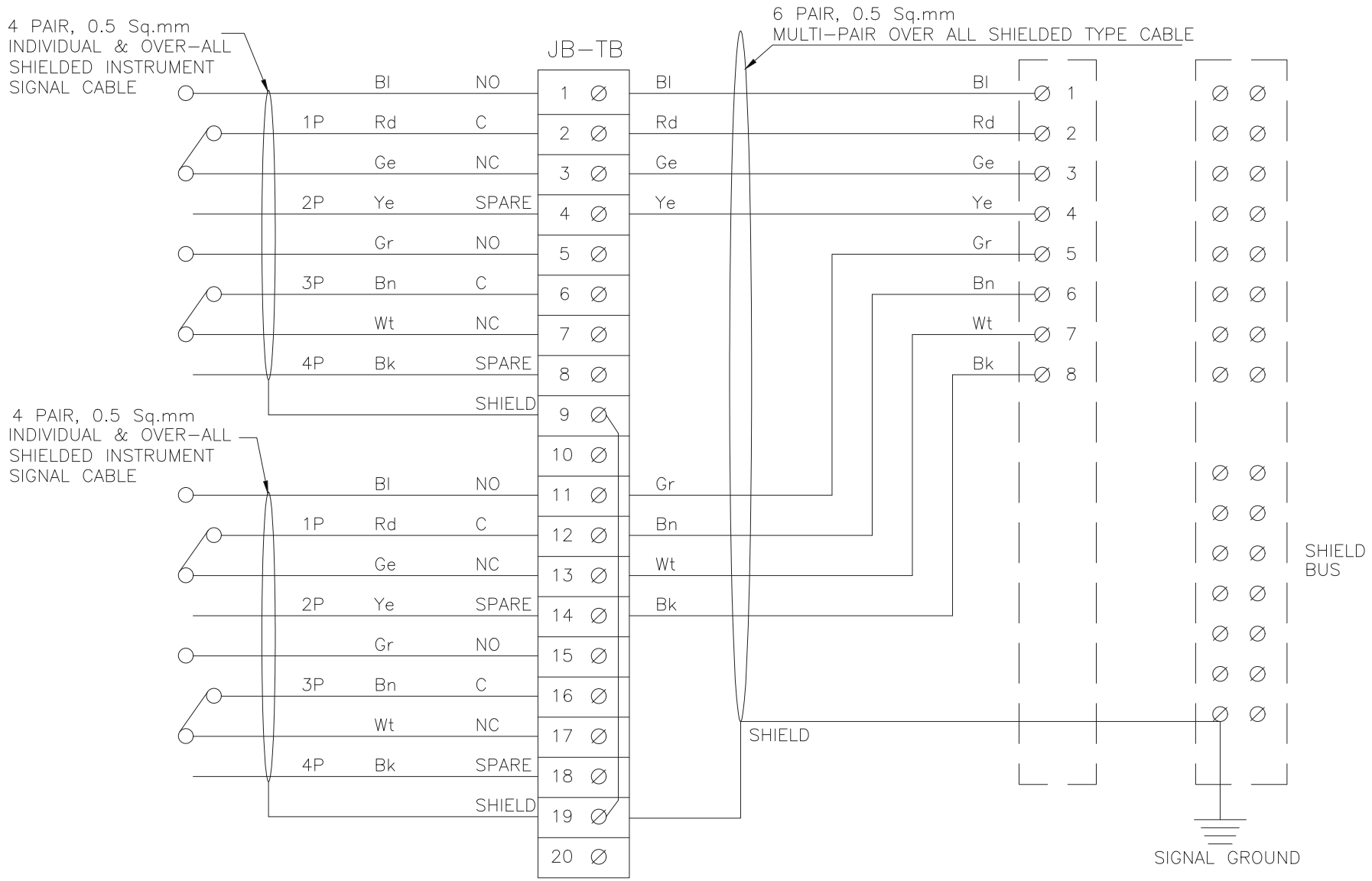
TITLE :- TMR CONFIGURATION DIAGRAM-TPS

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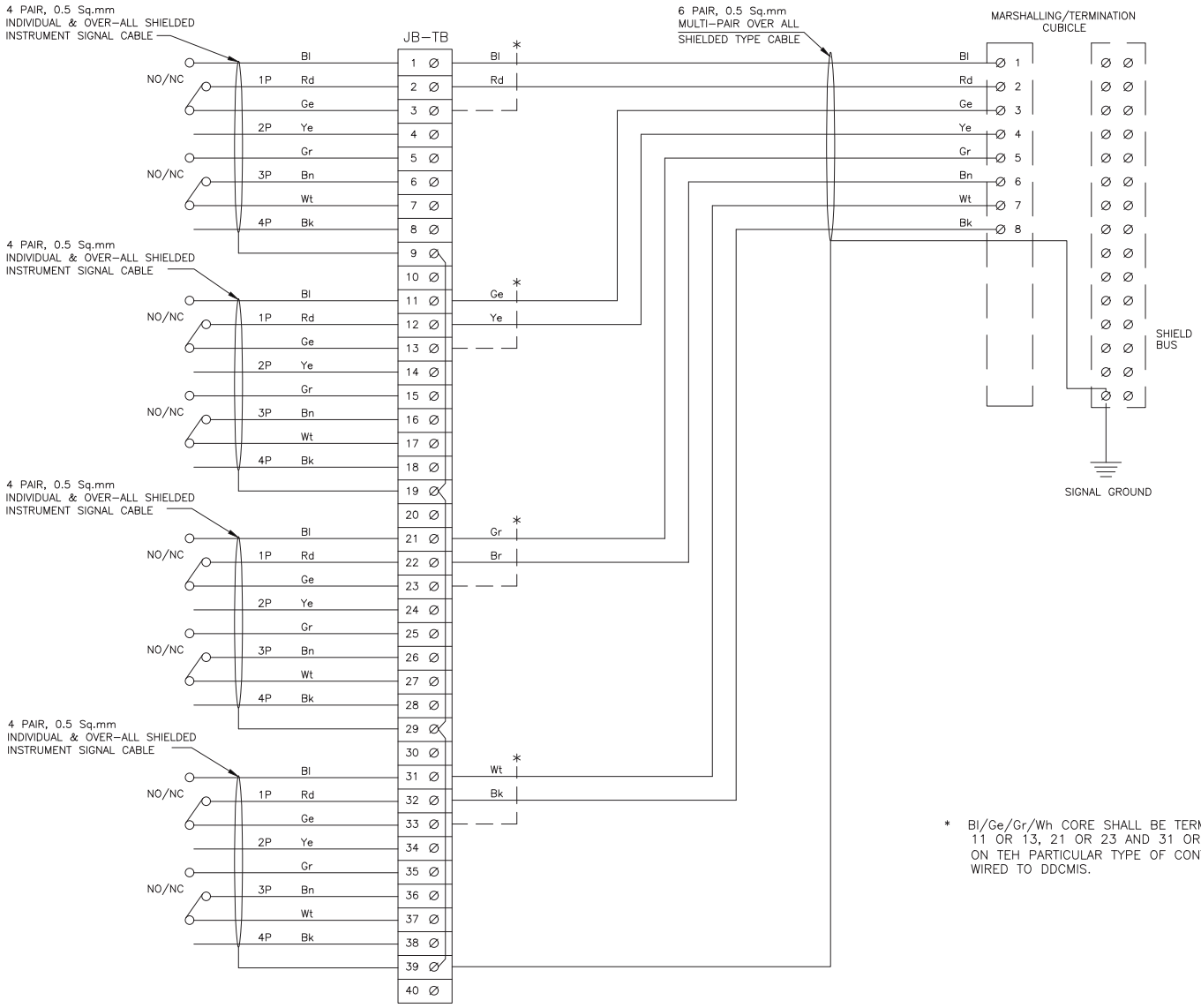
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CONSULTANT	DESEIN PRIVATE LIMITED CONSULTING ENGINEERS, NEW DELHI, INDIA
PROJECT:	1x800 MW EXPANSION UNIT DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR, HARYANA
TITLE :-	INTERFACING OF FIELD INSTRUMENTS/SWGR SWITCH (COC) TERMINATION DETAILS

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Sheet No. 2 of 15



* Bl/Ge/Gr/Wh CORE SHALL BE TERMINATED IN TERMINAL 1 OR 3. 11 OR 13, 21 OR 23 AND 31 OR 33 RESPECTIVELY DEPENDING ON TEH PARTICULAR TYPE OF CONTACT (NO OR NC) IS TO BE WIRED TO DDCMIS.

REFERENCE DRAWINGS.

NOTES

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PROJECT: 1x800 MW EXPANSION UNIT DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR, HARYANA

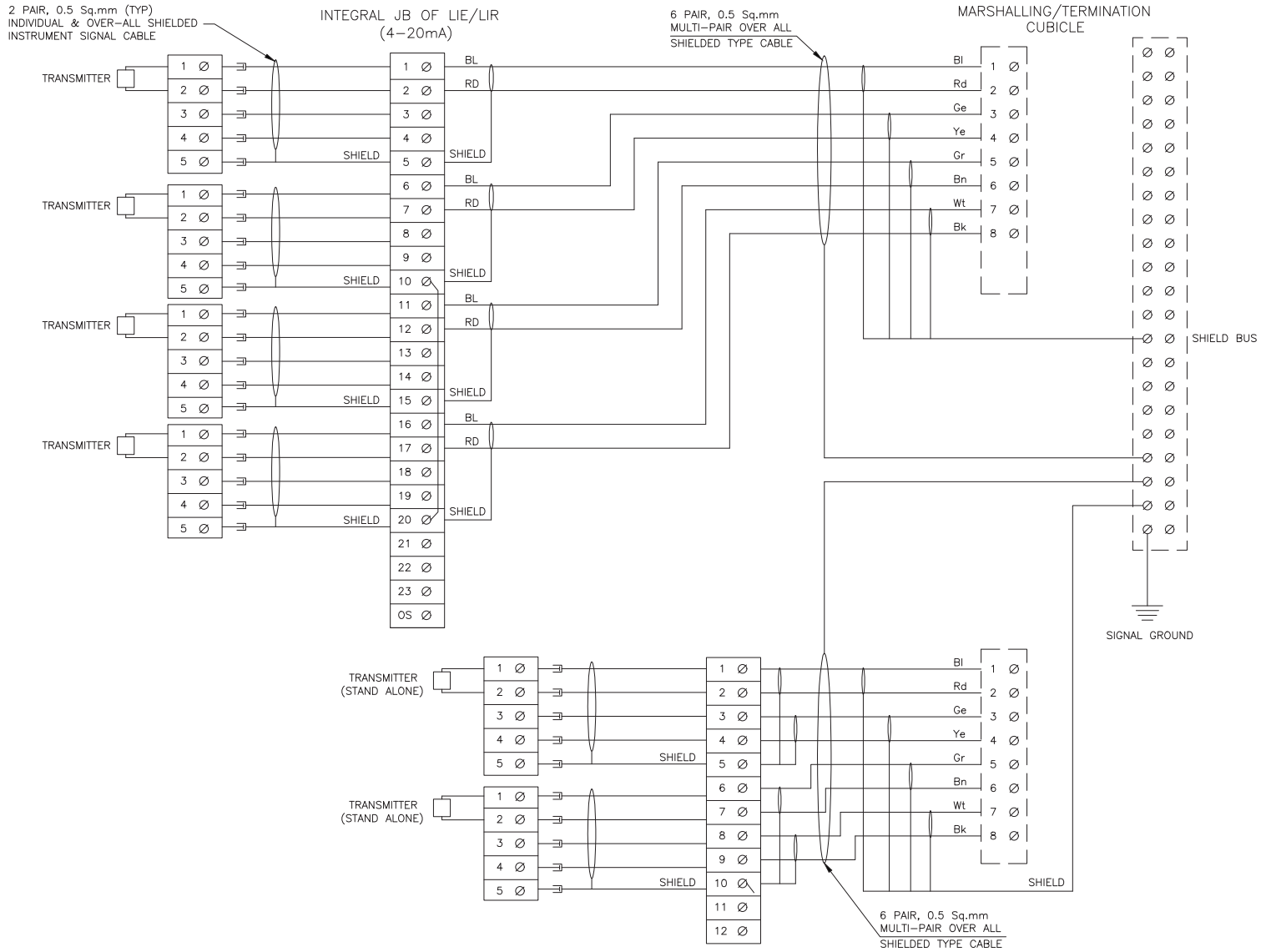
TITLE :- INTERFACING OF FIELD INSTRUMENTS SWITCH TERMINATION DETAILS NO/NC

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PROJECT: 1x800 MW EXPANSION UNIT DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR, HARYANA

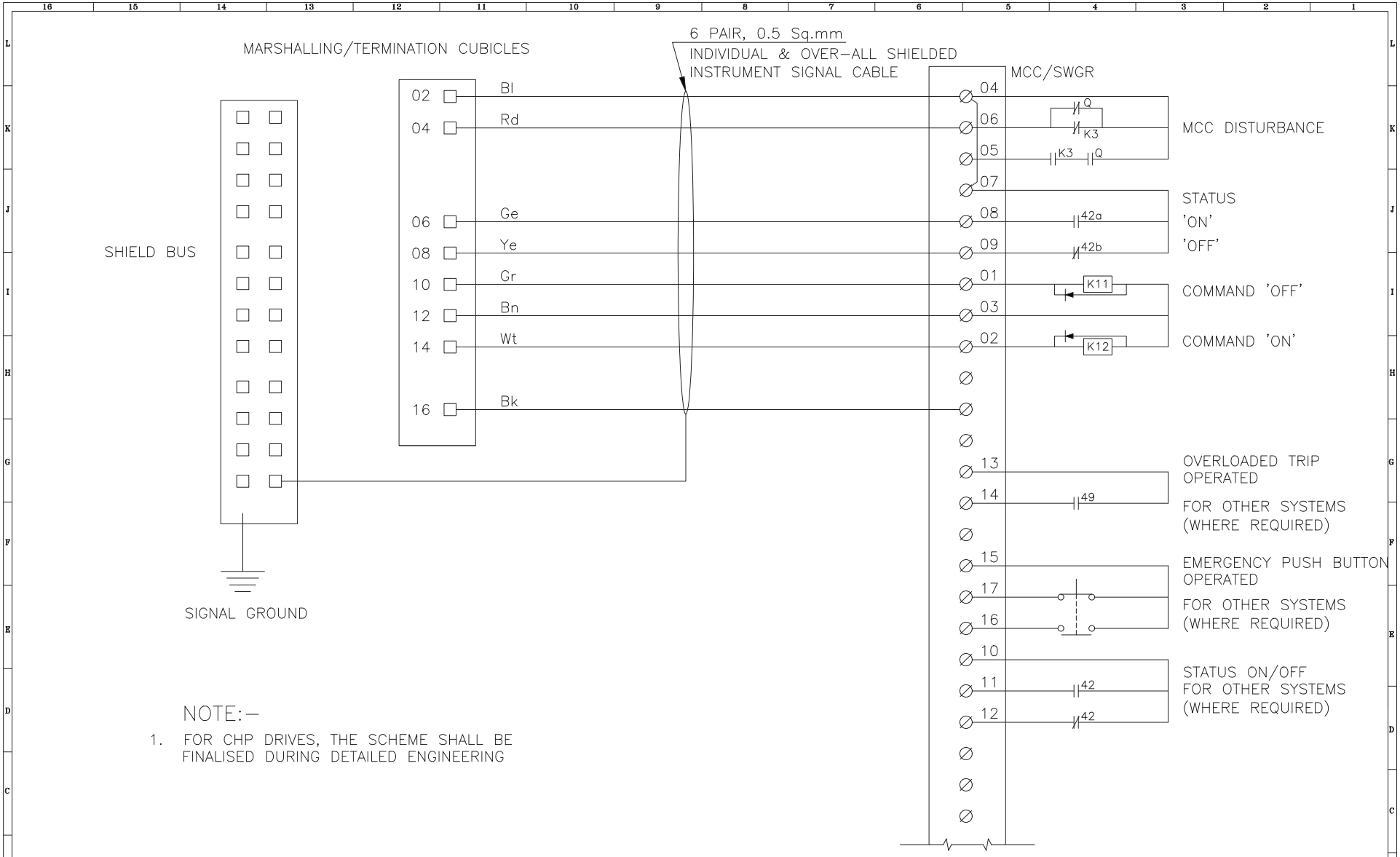
TITLE :- INTERFACING OF FIELD INSTRUMENTS 4-20mA

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Sheet No. 5 of 15



NOTE:-

1. FOR CHP DRIVES, THE SCHEME SHALL BE FINALISED DURING DETAILED ENGINEERING

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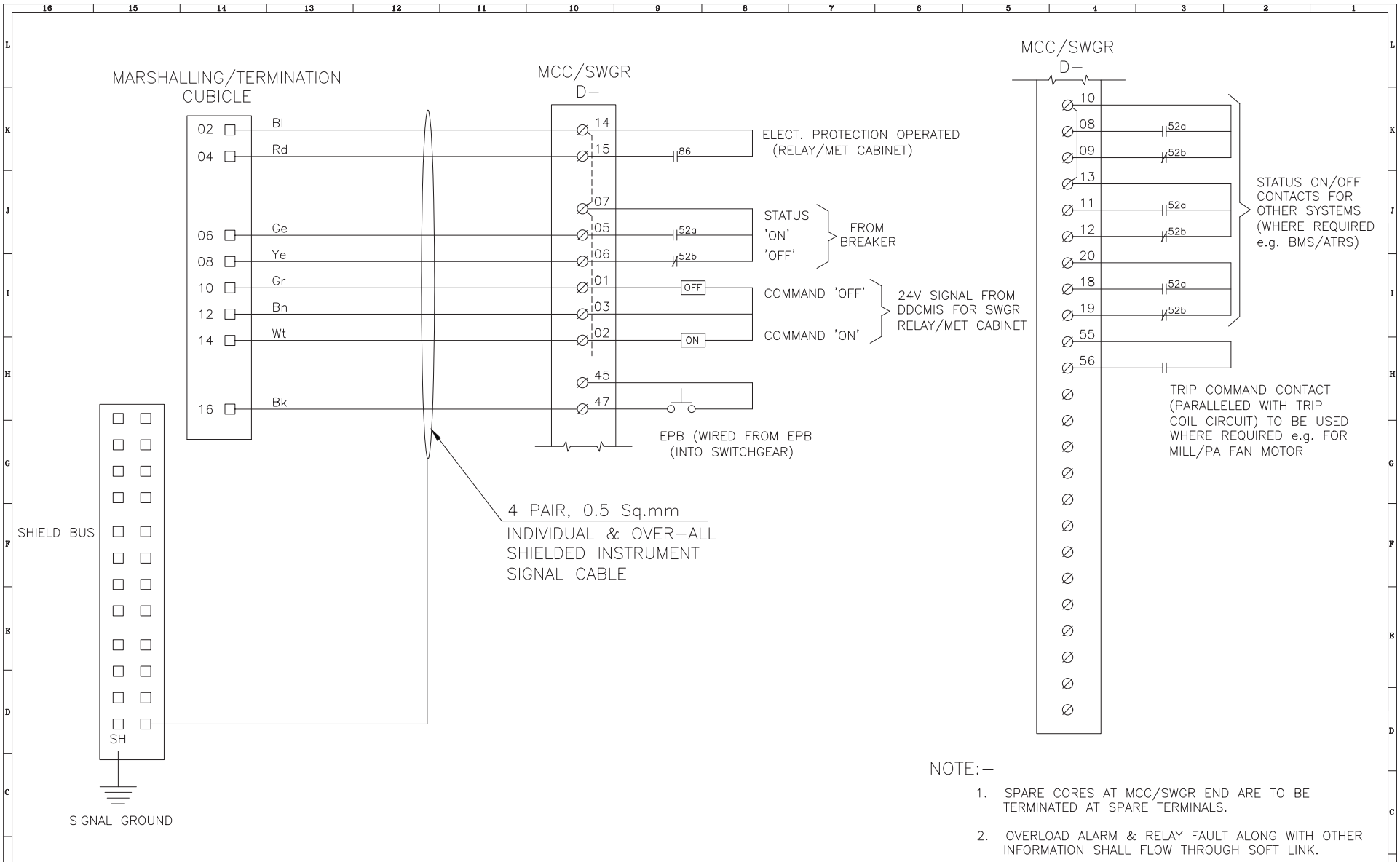
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CONSULTANT	DESEIN PRIVATE LIMITED CONSULTING ENGINEERS, NEW DELHI, INDIA
PROJECT:	1x800 MW EXPANSION UNIT DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR, HARYANA
TITLE :-	INTERFACING OF FIELD INSTRUMENTS INTERFACE OF OF DDCMIS WITH MCC/SWGR/ ACTUATOR (LT MOTORS)

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DWG. NO. 114-15-0106 REV. 0
Sheet No. 6 of 15

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NOTE:–

1. SPARE CORES AT MCC/SWGR END ARE TO BE TERMINATED AT SPARE TERMINALS.
2. OVERLOAD ALARM & RELAY FAULT ALONG WITH OTHER INFORMATION SHALL FLOW THROUGH SOFT LINK.

REFERENCE DRAWINGS.

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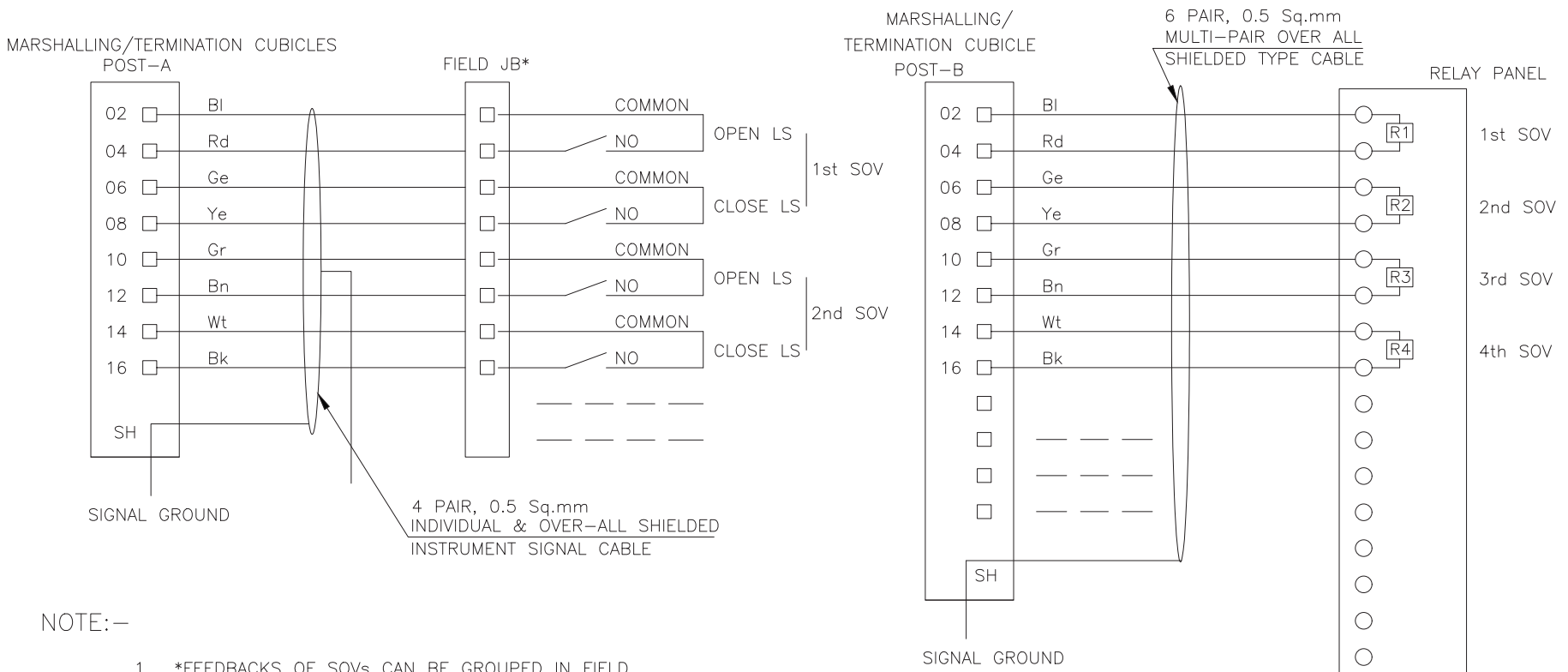
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CLIENT: HARYANA POWER GENERATION CORPORATION LTD.
CONSULTANT: DESEIN PRIVATE LIMITED, CONSULTING ENGINEERS, NEW DELHI, INDIA
PROJECT: 1x800 MW EXPANSION UNIT DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR, HARYANA
TITLE :– INTERFACING OF FIELD INSTRUMENTS INTERFACE OF OF DDCMIS WITH MCC/SWGR/ ACTUATOR (HT MOTORS)

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DWG. NO. 114–15–0108 REV. O
Sheet No. 8 of 15

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NOTE:–

1. *FEEDBACKS OF SOVs CAN BE GROUPED IN FIELD JB AND MULTI PAIR CABLE IS TO BE USED FROM FIELD JB TO MARSHALLING/TERMINATION CUBICLE FOR FEEDBACKS OF GROUP OF SOVs. TYP ARRANGEMENT IS SHOWN FOR A GROUP OF TWO SOVs WITH OPEN AND CLOSE LIMIT SWITCHES.
2. No. OF LIMIT SWITCHES/No. OF CONTACT IN LIMIT SWITCHES SHALL BE PROVIDED FOR EACH VALVE AS PER SPEC. REQUIREMENT/PHILOSPHY FOR RESPECTIVE SYSTEM.
3. ** MULTIPAIR CABLE IS TO BE USED FOR CONNECTION OF COMMAND OUTPUTS FROM MARSHALLING/TERMINATION CUBICLE TO RELAY PANEL FOR A GROUP OF SOVs.

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CONSULTING ENGINEERS, NEW DELHI, INDIA

PROJECT: 1x800 MW EXPANSION UNIT DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR, HARYANA

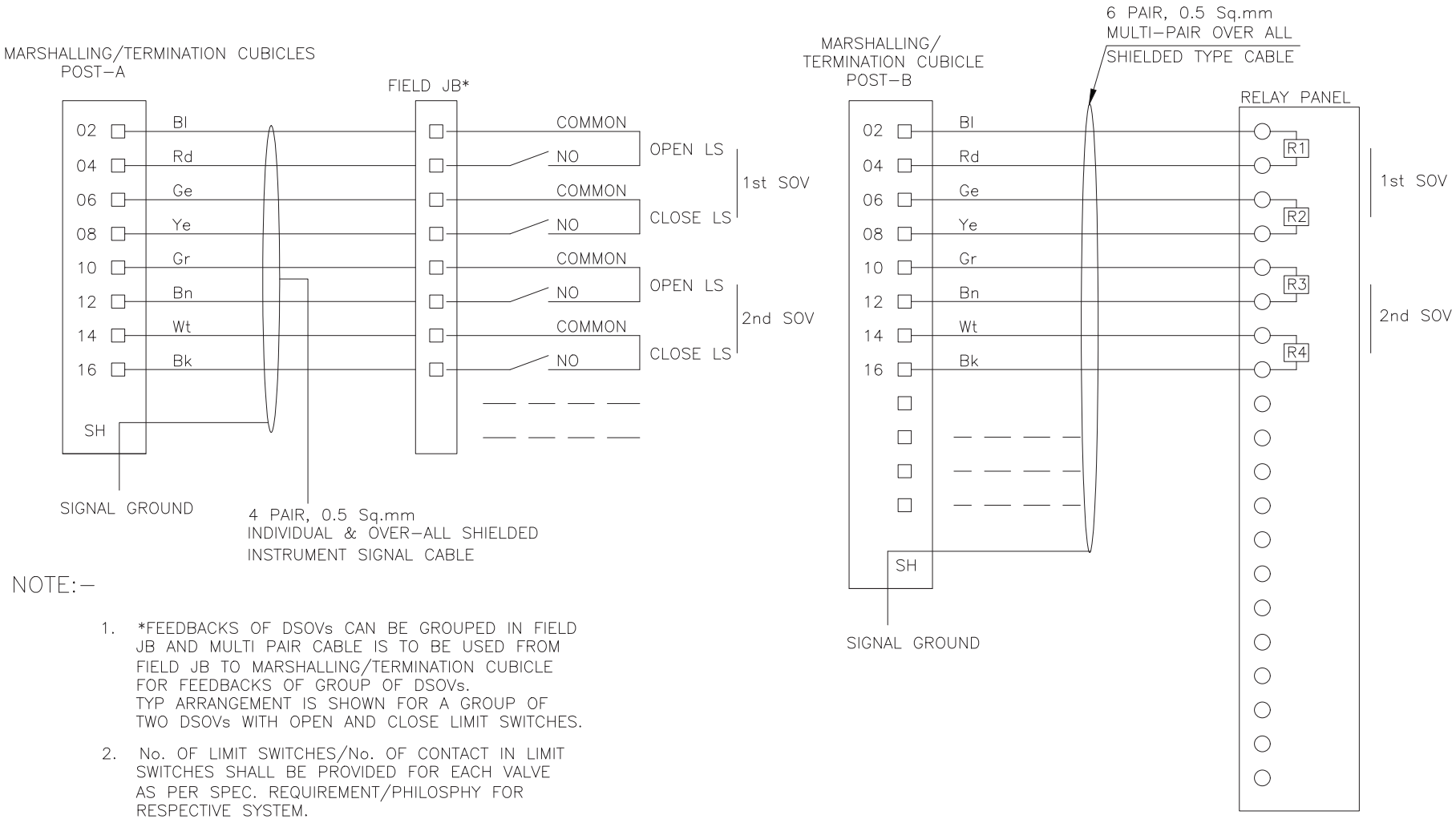
TITLE :– INTERFACING OF FIELD INSTRUMENTS INTERFACE OF DDCMIS WITH MCC/SWGR/ ACTUATOR (SINGLE COIL SOLENOID)

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DESIGNED	GR		26.09.2022
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JOB. NO. D–04041

DWG. NO. 114–15–0109 REV. O

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NOTE:–

1. *FEEDBACKS OF DSOVs CAN BE GROUPED IN FIELD JB AND MULTI PAIR CABLE IS TO BE USED FROM FIELD JB TO MARSHALLING/TERMINATION CUBICLE FOR FEEDBACKS OF GROUP OF DSOVs. TYP ARRANGEMENT IS SHOWN FOR A GROUP OF TWO DSOVs WITH OPEN AND CLOSE LIMIT SWITCHES.
2. No. OF LIMIT SWITCHES/No. OF CONTACT IN LIMIT SWITCHES SHALL BE PROVIDED FOR EACH VALVE AS PER SPEC. REQUIREMENT/PHILOSPHY FOR RESPECTIVE SYSTEM.
3. ** MULTIPAIR CABLE IS TO BE USED FOR CONNECTION OF COMMAND OUTPUTS FROM MARSHALLING/TERMINATION CUBICLE TO RELAY PANEL FOR A GROUP OF DSOVs.

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CONSULTANT: DESEIN PRIVATE LIMITED
CONSULTING ENGINEERS, NEW DELHI, INDIA

PROJECT: 1x800 MW EXPANSION UNIT DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR, HARYANA

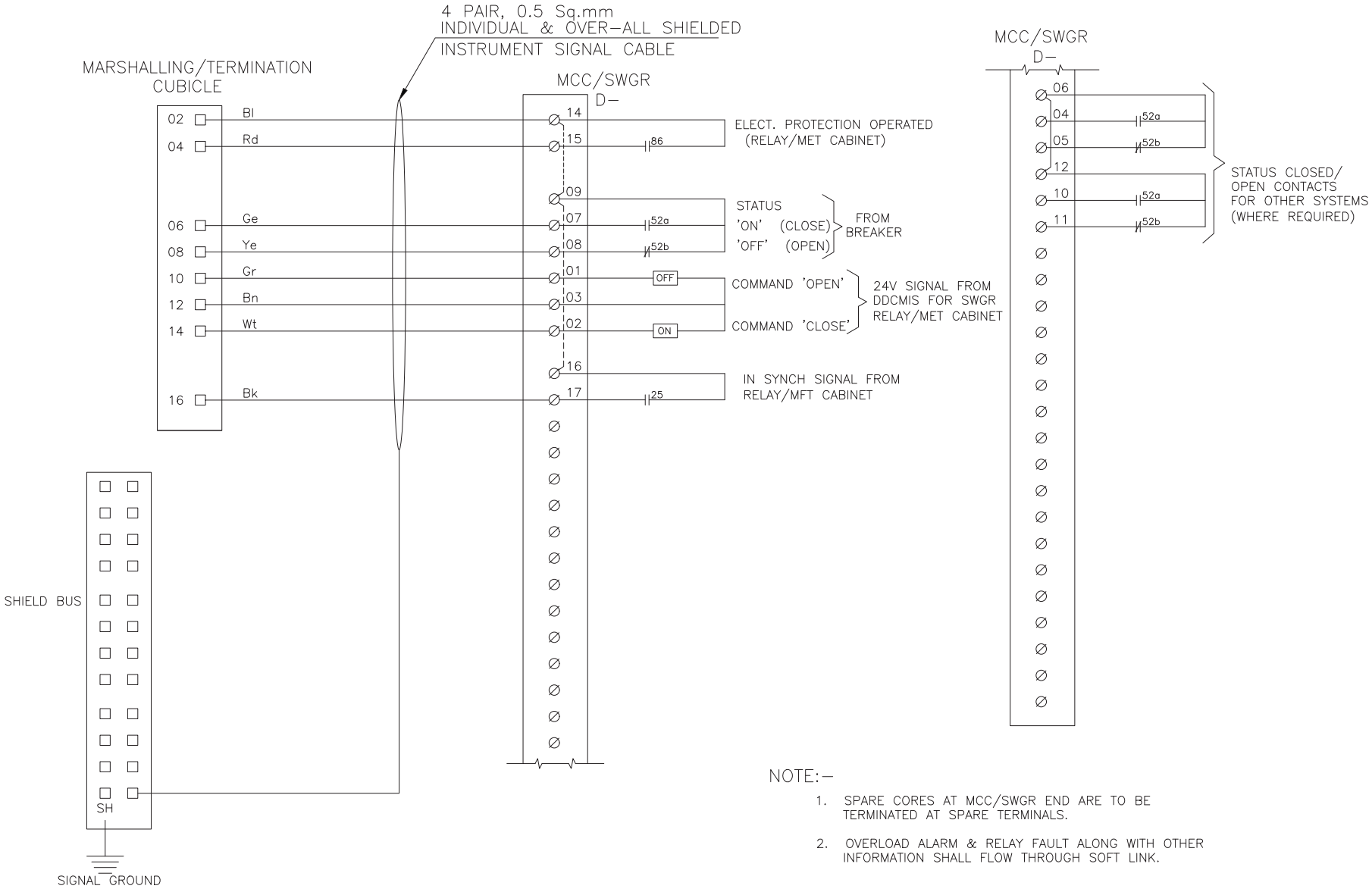
TITLE :– INTERFACING OF FIELD INSTRUMENTS INTERFACE OF DDCMIS WITH MCC/SWGR/ ACTUATOR (DOUBLE COIL SOLENOID)

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NOTE:-

1. SPARE CORES AT MCC/SWGR END ARE TO BE TERMINATED AT SPARE TERMINALS.
2. OVERLOAD ALARM & RELAY FAULT ALONG WITH OTHER INFORMATION SHALL FLOW THROUGH SOFT LINK.

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CONSULTANT: DESEIN PRIVATE LIMITED, CONSULTING ENGINEERS, NEW DELHI, INDIA

PROJECT: 1x800 MW EXPANSION UNIT DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR, HARYANA

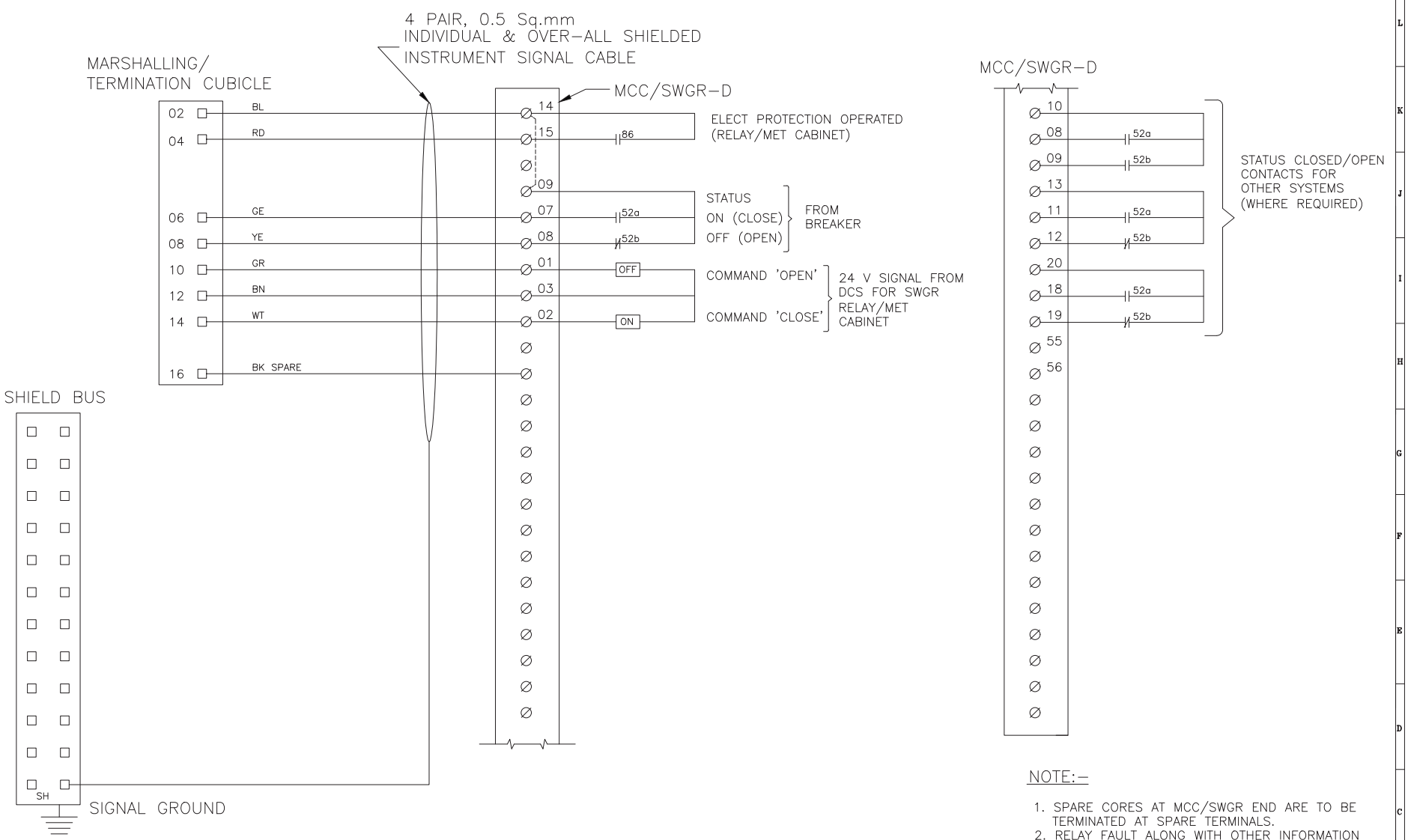
TITLE :- INTERFACING OF FIELD INSTRUMENTS INTERFACE OF DDCMIS WITH MCC/SWGR/ ACTUATOR (ELECT. BKR.-SYNCH.-LT)

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DWG. NO. 114-15-0111 REV. 0

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NOTE:-

1. SPARE CORES AT MCC/SWGR END ARE TO BE TERMINATED AT SPARE TERMINALS.
2. RELAY FAULT ALONG WITH OTHER INFORMATION SHALL FLOW THROUGH SOFT LINK.

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PROJECT: 1x800 MW EXPANSION UNIT DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR, HARYANA

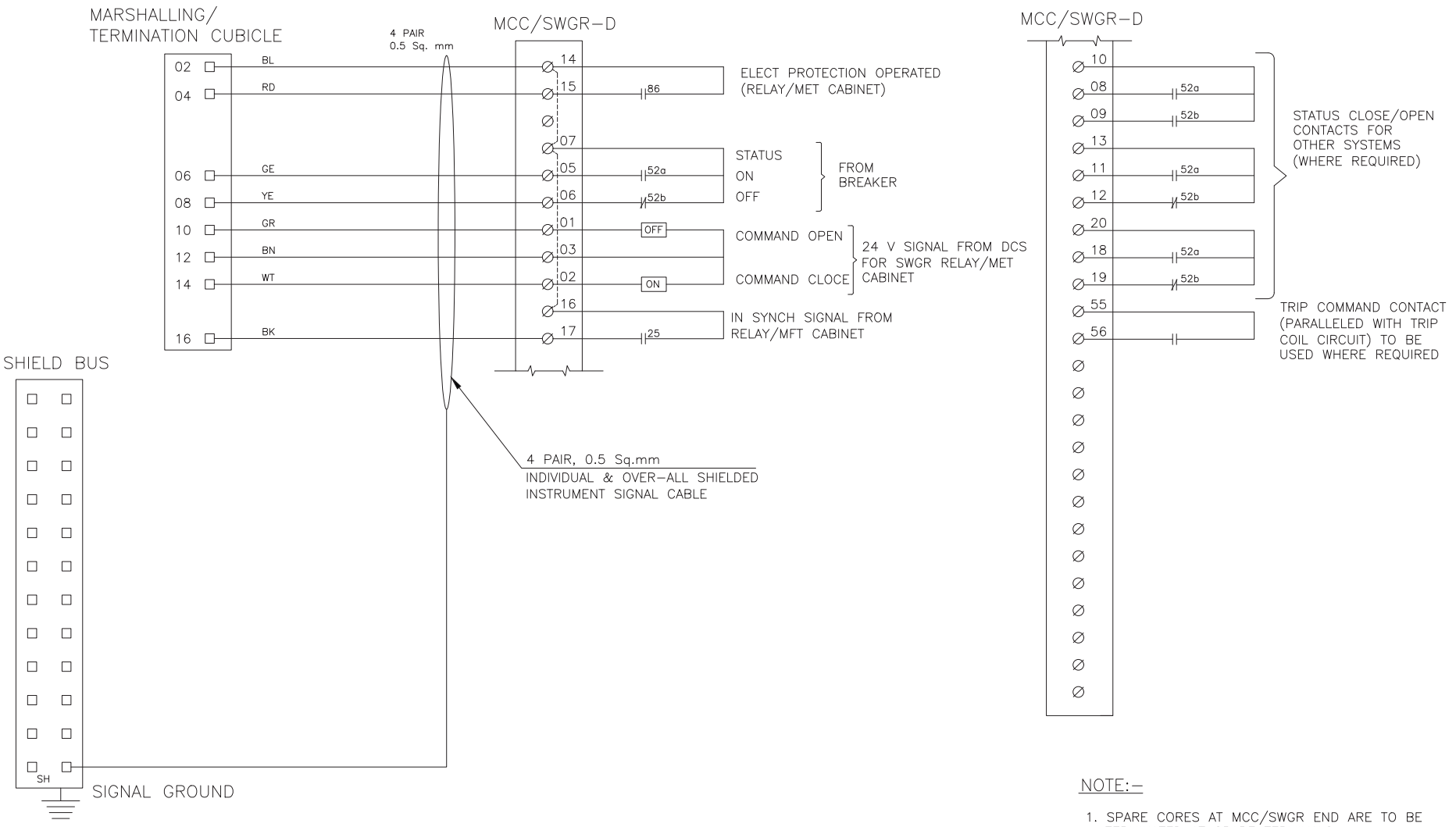
TITLE :- INTERFACING OF FIELD INSTRUMENTS INTERFACE OF DDCMIS WITH MCC/SWGR/ ACTUATOR (ELECT. BKR.-NON SYNCH.-LT)

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DWG. NO. 114-15-0112 REV. 0

Sheet No. 12 of 15



NOTE:–

1. SPARE CORES AT MCC/SWGR END ARE TO BE TERMINATED AT SPARE TERMINALS.
2. RELAY FAULT ALONG WITH OTHER INFORMATION SHALL FLOW THROUGH SOFT LINK.

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CONSULTANT: DESEIN PRIVATE LIMITED
CONSULTING ENGINEERS, NEW DELHI, INDIA

PROJECT: 1x800 MW EXPANSION UNIT DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR, HARYANA

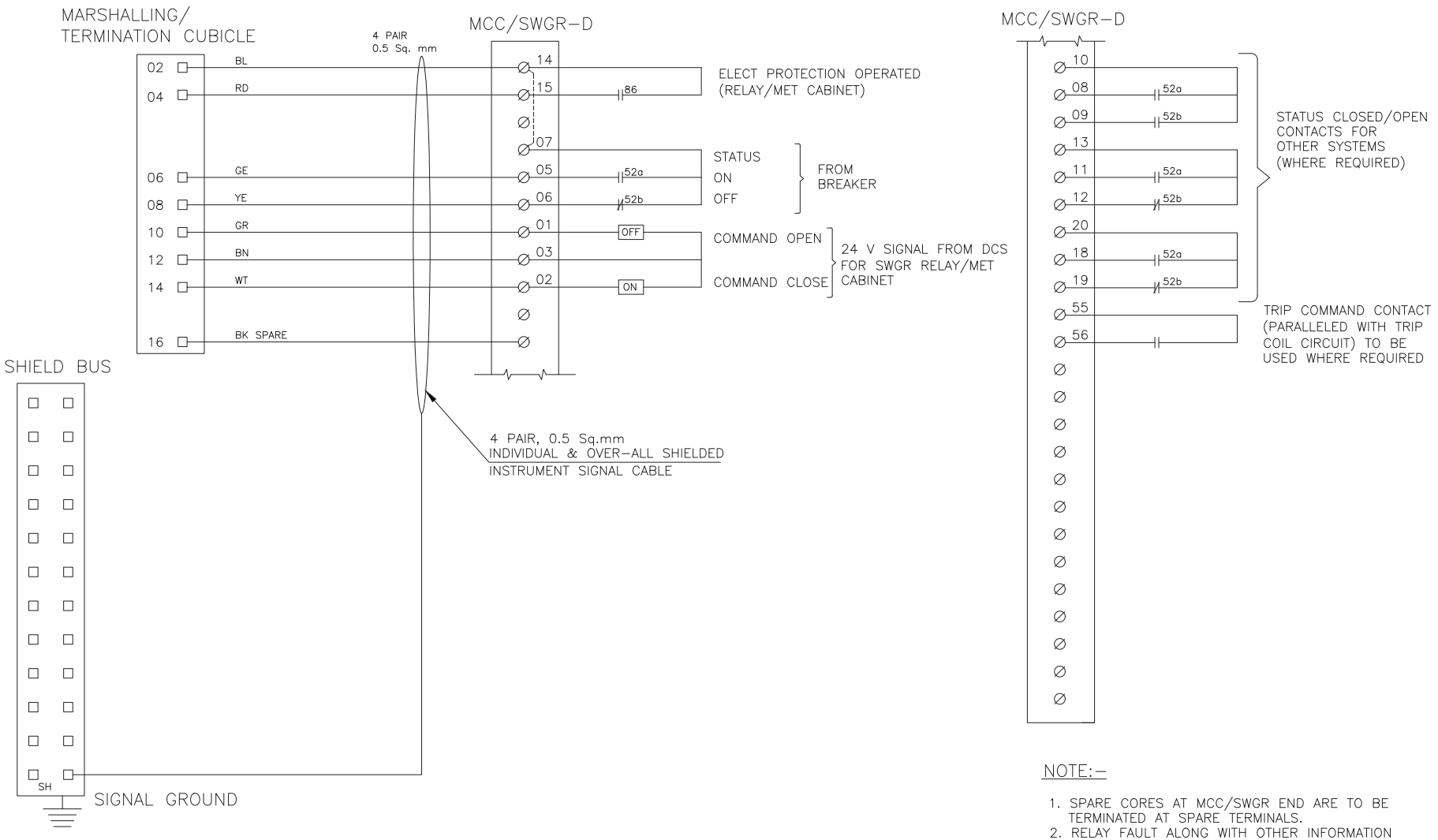
TITLE :– INTERFACING OF FIELD INSTRUMENTS INTERFACE OF DDCMIS WITH MCC/SWGR/ ACTUATOR (ELECT. BKR.–NON SYNCH.–LT)

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DWG. NO. 114–15–0113 REV. 0

Sheet No. 13 of 15



NOTE:–

1. SPARE CORES AT MCC/SWGR END ARE TO BE TERMINATED AT SPARE TERMINALS.
2. RELAY FAULT ALONG WITH OTHER INFORMATION SHALL FLOW THROUGH SOFT LINK.

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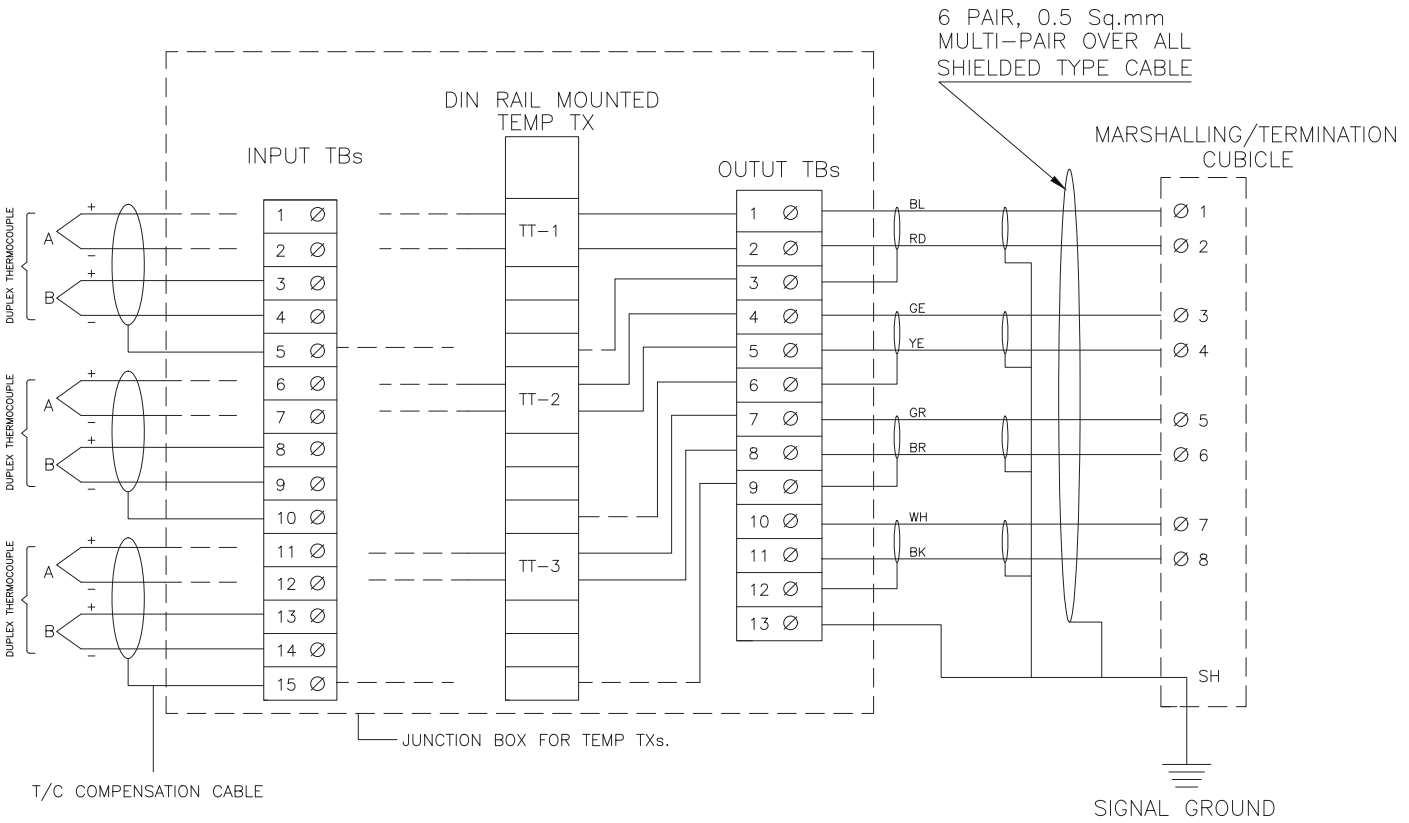
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Sheet No. 14 of 15



NOTE:-

1. ABOVE IS THE TYP DRG. FOR DIN RAIL MOUNTED TEMP TRANSMITTER FOR T/C APPLICATION. EXACT TYPE OF TEMP. TRANSMITTERS SHALL BE AS PER PART-A OF SPECIFICATION.

2. THE EXACT GROUPING OF TEMP. TXs SHALL BE FINALISED DURING DETAILED ENGG. STAGE

3. AFTER GLANDING OF T/C CABLES ON JB, THE CABLE PAIR OF FIRST ELEMENT WILL BE DIRECTLY CONNECTED TO TT AND FOR CABLE PAIR OF SECOND ELEMENT LOOP SHALL BE KEPT, BEFORE TERMINATION AT INPUT TBs FOR FUTURE USE.

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PROJECT: 1x800 MW EXPANSION UNIT DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR, HARYANA

TITLE :- INTERFACING OF FIELD INSTRUMENTS TYPICAL T/C CONNECTION WITH TEMP TXs IN JBs

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INSTRUMENTATION CABLE TERMINATION PHILOSOPHY

9.08.00 **Field Mounted Local Junction Boxes details and cable termination criteria**

i. Junction Boxes material shall be stainless-steel SS-304 with 1.5mm thickness, IP66 rating, RoHS compliant, UL / TÜV Rheinland certified and manufactured in accordance with IEC 62208, ensuring the highest quality

ii. Type of Enclosure shall be IP-66 rated Flame proof/Weatherproof /Explosion Proof as per area classification. Design shall be as per NEC-370 Article 18, 19 & 20 with IK-08 Enclosure Protection class against external mechanical stresses as per EN 50102/IEC 62262.

iii. No. of Ways shall be 12/24/36/48/64/72/96/128 with 20% spare terminals.

iv. Each junction box shall be provided with sufficient terminals for the individual termination of all spare cores within the interconnecting cabling. As minimum, additional 20% wired terminals shall be provided for future use.

v. Cable entry shall be Bottom or Side.

vi. Cable glands shall be Double compression type – Nickel plated Brass/SS316 with PVC hoods.

vii. Mounting shall be Indoor/ Outdoor and IP55 rating for Junction Boxes shall apply for Indoor applications only.

viii. Terminals shall be from Phoenix/Wago (screw less rail mounted cage clamp type spring loaded suitable for conductor size up to 2.5 sq. mm)

ix. Corrosion testing shall be conducted form high capacity corrosion testing laboratory with fast response time and same shall be a TÜV Rheinland's accredited corrosion testing laboratory. Relevant regulations, codes and standards related to corrosion testing shall apply like ASTM A262, SEP 1877, ISO 9227, ISO 3651-1, ISO 3651-1 etc. Salt spray tests shall be conducted in accordance with ISO 9227:2012(en) i.e. Corrosion tests in artificial atmospheres.

x. Doors shall be hinged /lockable type. The door hinges shall be easily swappable to opposite side for single-door enclosure at 130° opening angle as per relevant applicable VDI standards. Doors shall be provided with double bit cam locks to ensure rigid and in position locking. Lock insert shall be of Die-cast zinc type, nickel-plated with 3 mm cam lock and double-bit insert in accordance with DIN 43668

xi. Terminals shall be from Phoenix/Wago (screw less rail mounted cage clamp type spring loaded suitable conductor size up to 2.5 sq. mm) Grounding should be two terminals for body shield ground.

xii. Suitable mounting clamps and other accessories shall be in scope of Bidder.

xiii. The brackets, bolts, nuts, screws, glands, lugs required for erection shall be of SS304, included in Bidder scope of supply.

xiv. High voltage & insulation resistance test shall also be conducted.

xv. M6 Ni plated Brass earthing stud shall be provided (external 2 nos. internal 1 no.)

xvi. Colour shall be decided during detailed engineering & shall subject to owner's approval.

xvii. Gasket (Normal)- Neoprene/Polyurethene thickness 6.0 mm. Silicon for high Temp. area. shall be provided.

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 **cable/**Wire size shall be utilized for internal wiring & UPS power cables (In addition, voltage drop calculation and distance between source & destination shall also be considered by bidder, while finalising the cable/wire size) :

a.	Current (4-20 mA) Low voltage signals (AI/AO & DI signals)	:	0.75 sq.mm
b.	DO signals, Ammeter/ voltmeter circuit,control switches, indicator,recorder	:	1.5 sq.mm
c.	Internal Illumination & 24 V DC Power supply	:	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

sand filling at bottom and sand, soil filling at top with cement concrete by bidder;

While crossing canals/river- to be laid in rodent proof HDPE conduits within hume pipe by bidder.

10 Laying of Network Cable (UTP/STP) :

Out side Building Area- to be laid necessarily inside GI conduits with support from cable tray / Tressle structure.

Inside Building Area- to be laid necessarily inside GI conduits on separate cable sub-trays.

9.07.01 Bidder shall supply and install all cable accessories and fittings like Light 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.

9.07.03 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.

9.07.04 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.

9.07.05 **Cable Glands**

Cables shall be terminated using double compression type cable glands. Cable glands shall conform to BS: 6121 & IP-67 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 OR SS316 (As approved by owner). Thickness of plating shall not be less than 10 micron. All washers and hardware shall be made of brass with nickel chrome plating OR SS316 (As approved by owner). Rubber components shall be of neoprene and of tested quality.

9.08.00 **Field Mounted Local Junction Boxes details and cable termination criteria**

i. Junction Boxes material shall be stainless-steel SS-304 with 1.5mm thickness, IP66 rating, RoHS compliant, UL / TÜV Rheinland certified and manufactured in accordance with IEC 62208, ensuring the highest quality

ii. Type of Enclosure shall be IP-66 rated Flame proof/Weatherproof /Explosion Proof as per area classification. Design shall be as per NEC-370 Article 18, 19 & 20 with IK-08 Enclosure Protection class against external mechanical stresses as per EN 50102/IEC 62262.

iii. No. of Ways shall be 12/24/36/48/64/72/96/128 with 20% spare terminals.

iv. Each junction box shall be provided with sufficient terminals for the individual termination of all spare cores within the interconnecting cabling. As minimum, additional 20% wired terminals shall be provided for future use.

v. Cable entry shall be Bottom or Side.

vi. Cable glands shall be Double compression type – Nickel plated Brass/SS316 with PVC hoods.

vii. Mounting shall be Indoor/ Outdoor and IP55 rating for Junction Boxes shall apply for Indoor applications only.

viii. Terminals shall be from Phoenix/Wago (screw less rail mounted cage clamp type spring loaded suitable for conductor size up to 2.5 sq. mm)

ix. Corrosion testing shall be conducted form high capacity corrosion testing laboratory with fast response time and same shall be a TÜV Rheinland's accredited corrosion testing laboratory. Relevant regulations, codes and standards related to corrosion testing shall apply like ASTM A262, SEP 1877, ISO 9227, ISO 3651-1, ISO 3651-1 etc. Salt spray tests shall be conducted in accordance with ISO 9227:2012(en) i.e. Corrosion tests in artificial atmospheres.

x. Doors shall be hinged /lockable type. The door hinges shall be easily swappable to opposite side for single-door enclosure at 130° opening angle as per relevant applicable VDI standards. Doors shall be provided with double bit cam locks to ensure rigid and in position locking. Lock insert shall be of Die-cast zinc type, nickel-plated with 3 mm cam lock and double-bit insert in accordance with DIN 43668

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xvi. Colour shall be decided during detailed engineering & shall subject to owner's approval.

xvii. Gasket (Normal)- Neoprene/Polyurethene thickness 6.0 mm. Silicon for high Temp. area. shall be provided.

QUALITY ASSURANCE PLAN/ CHECK LIST

TESTS TO BE PERFORMED FOR FIELD INSTRUMENTS & EQUIPMENT

1.	Pressure Gauges
	Calibration, Accuracy Test, Hydro test (1.5 times max. pr.)
2.	Pressure switches
	Calibration test / Hydro test / Contact rating test / Accuracy test / Repeatability test
3.	Pressure Transmitter
	Calibration test / Hydro test / Leak test / Over range test / Accuracy test / Repeatability test.
4.	Differential Pressure Gauges
	Calibration test / Hydro test / Leak test / Over range test / Accuracy test / Repeatability test.
5.	Differential Pressure Switches

	Calibration test / Hydro test / Contact rating test / Leak test / Accuracy test / Repeatability test.
6.	Differential pressure transmitter
	Calibration test / Hydro test / Leak test / Over range test / Accuracy test / Repeatability test.
7.	Thermometers
	Calibration / Material test / Accuracy test / Bore concentricity: $\pm$ 5% of wall thickness / Hydrostatic test for TW (1.5 times max. pr.)
8.	Temperature switch
	Calibration / Material test / Accuracy test / Bore concentricity: 1.5% of wall thickness / Hydrostatic test for TW (1.5 times max. pr.) / Contact rating test.
9.	Resistance temperature detector assembly.
	Calibration / Material test / Bore concentricity test / Insulation test ($\leq$ 500 MΩ at 500V DC) as per ISA, Hydro test for TW. Bore concentricity: $\pm$ 5% of wall thickness, Accuracy test.
10.	Thermocouple assembly
	Calibration / Material test, Insulation test ($\leq$ 500 Ω at 500 V, DC) as per ISA, Hydro static test (1.5 times max. pr.), Bore concentricity: $\pm$ 5% of wall thickness.
11.	Temperature Transmitter
	Calibration test / Accuracy test /Ambient temperature error test
12.	Thermowells
	Material test / Bore concentricity: $\pm$ 5% of wall thickness / Hydrostatic test for TW (1.5 times max. pr.)
13	Interposing Relay
	Functional Test/temperature rise test/high voltage test/limits of operation test/insulation.
14.	Level Gauges
	Hydrostatic test / Material test / Seat leakage test / Ball check test.
15.	Level switches (Magnetic)
	Material test / Contact rating test / Hydro test / Calibration test.
16.	Level gauge (prope)
	Material test/contact rating test/Hydro test/Calibration test
17.	Flow Switch
	Material test / Hydro static test (1.5 times max. pr.) / functional test.
18.	Flow glasses
	Material test / Hydrostatic test (1.5 times max. pr.) / functional test.
19.	Variable area flow meters

	Calibration test / Material test / Hydrostatic test (1.5 times max. pr.)
20.	Flow element
	100% Radiography test / Hydro test / Calibration test, IBR Certificate.
	Calibration test for flow element shall be witnessed by Owner/Consultant.
21.	Control valves/Pneumatic block valve/Pressure regulating valve –Refer Vol-V Part-B chapter 11.
22.	Pneumatic Block Valves
	a) IBR certificate form III C b) Hydrostatic test : ANSI B 16.34 c) Seat leakage test : As per ANSI B 16-104 d) CV test: As per ISA procedure e) Magnetic particle test ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 DegC) f) Liquid penetration test: ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 DegC) g) Radiography test: ANSI B 16.34 special class h) Calibration and Hysteresis test i) Actuator leakage test j) Also refer Vol-V Part-B chapter 11 for further details.
23.	Pressure Regulating Valve
	a) IBR certificate form III C b) Hydrostatic test : ANSI B 16.34 c) Seat leakage test : As per ANSI B 16-104 d) CV test: As per ISA procedure e) Magnetic particle test ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 DegC) f) Liquid penetration test: ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 DegC) g) Radiography test: ANSI B 16.34 special class h) Calibration and Hysteresis test i) Actuator leakage test j) Also refer Vol-V Part-B chapter 11 for further details.
24.	Position transmitters
	Calibration / hysteresis and Accuracy test
25.	Electro Pneumatic Convertors
	Calibration test / Accuracy test
26.	Solenoid valves
	Hydrotest / Seat leakage test / CV test / Coil insulation test
27.	Air filter regulators

	Calibration test / Accuracy test
28.	Junction Boxes
	Test for degree of protection / Material test
29.	Transmitter Racks :
	Hydro test, air leak test for piping / tubing and fittings. IBR certification as required for tubing / piping and fittings.
30.	Tests for terminal blocks
	Test for moulding for flame resistant, Non-hygroscopic and Decarbonised / Insulation test between terminals / Insulation between terminal block and frame.
31.	Thermocouple extension cable & Instrumentation Cables and Fiber Optical Cables
	Thermo-emf characteristic / Continuity test / Measurement on capacitance, inductance and loop resistance / Insulation resistance / High voltage test as per latest IS / Tensile and elongation test / Oxygen index test / Any other test applicable. (Also refer Vol-V Part-B chapter 9 for further details). For Deatils of type and acceptance tests for Instrumentation Cables refer Vol-V Part-B chapter 9. For Deatils of tests for Fiber Optical Cables refer Vol-V Part-B chapter 9.
32.	Mass flow meter
	Performance test / Calibration test / Hydrostatic test.
33.	Boiler Level Gauge
	Hydrostatic test / Material test / Seat leakage test / IBR Certificate
34.	pH/Conductivity measurement / Silica / Dissolved oxygen analysers:
	Calibration test, Accuracy test
35.	Sample cooler :
	Hydro test, IBR Certificate
36.	Sampling racks :
	Hydro test, IBR Certificate for tubes and fittings.
37.	S02 / Nox analyser / SPM analyser:
	Calibration test, accuracy test
38.	Interposing relay
	Functional test, temperature rise test, H.V test, Insulation test
39.	Local Panels : Visual inspection, wiring & continuity check, H.V. and I.R. tests on panels, checking of bill of materials, functional tests.
40	Wiring Termination & Accessories
	Routine test: Conductor resistance test/High voltage test/Impulse dielectric test/insulation test/Humidity test/Temperature rise test on power circuits/short time current test on power circuits.

	Type test:Annealing test/Test for insulation and sheath/ Flame retardance test - a) Oxygen index, b) Flammability / Test for acid gas generation/test for water absorption/wet dielectric test
41	Marshalling/System cabinets
	Verification of degree of protection/Electrical tests as detailed under wiring Termination& accessories/Type test and routine test as per relevant Indian standards.
	Notes:
	1. Test Certificates in addition to inspection at manufacturer's works shall be furnished for all the instruments for Owner / Consultant's review. 2. Above Test to be witnessed shall be finalized by Owner.
	3. In addition to above test, test as per approved QAP shall also be witnessed by owner.
	4. Accuracy test, Calibration test, Overload/Over range protection test, IR test, Hydro test & Leakage test as applicable for measuring instruments are covered under the routine test. The test certificates/reports shall be furnished by bidder to owner for approval.

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR SOLENOID VALVES

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	TYPE						
	MAKE						
	MODEL No.						
2	MATERIAL (BODY. PLUNGER/TRIM)			P	W	V	
3	PORT SIZE			P	W	V	
4	CABLE CONNECTION SIZE			P	W	V	
5	ENCLOSURE CLASS			P	W	V	TYPE TEST CERTIFICATE TO BE FURNISHED BY VENDOR
6	No. OF COILS & INSULATION CLASS			P	W	V	TEST CERTIFICATE TO BE FURNISHED FOR INSULATION CLASS BY VENDOR
7	POWER SUPPLY CHECK			P	W	V	
8	IR / HV TEST			P	W	V	
9	FUCTIONAL TEST			P	W	V	

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.

CI.2. MEASURING INSTRUMENTS (PRIMARY AND SECONDARY)

MEASURING INSTRUMENTS (PRIMARY AND SECONDARY)

TESTS / ITEMS	Dimensions (R)	Make, Model, Type, Rating (R)	Process / Electrical connection (R)	Calibration (R)	Test as per standard(R)	Insulation Resistance (R)	IBR Certification (if applicable)(R)	Hydro Test(R)	Material Test certificate ®
1. PR Gauge (IS-3624)	Y	Y	Y	Y	Y				
2. Temp. Gauge (BS-5235)	Y	Y	Y	Y	Y				
3. Pr./D.P.Switch (BS-6134)	Y	Y	Y	Y	Y	Y			
4. Electronic Transmitter (IEC-770)	Y	Y	Y	Y	Y	Y			
5. Temp. Switch	Y	Y	Y	Y	Y	Y			
6. Recorder (IS-9319/ANSI C-39.4)	Y	Y	Y	Y	Y	Y			
7. Vertical indicators	Y	Y	Y	Y		Y			
8. Digital Indicators	Y	Y	Y	Y		Y			
9. Integrators	Y	Y	Y	Y					
10. Electrical Metering Instrument (IS-1248)	Y	Y	Y	Y	Y	Y			
11. Transducer (IEC-688)	Y	Y	Y	Y	Y	Y			
12. Thermocouples (ANSI-MC-96.1)	Y	Y	Y	Y	Y	Y			
13. RTD (IEC-751)	Y	Y	Y	Y	Y	Y			
14. Thermowell	Y		Y				Y	Y	Y

R-Routine Test A- Acceptance Test Y – Test applicable

Note:

1) Detailed procedure of Burn-in and Elevated Temperature test shall be as per Quality Assurance Programme in General Technical Conditions.
2) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted along with relevant supporting documents.
3) Acceptance tests shall be carried out in presence of owner's representative.

TESTS / ITEMS	Dimensions (R)	Make, Model, Type, Rating (R)	Process / Electrical connection (R)	Calibration (R)	Requirement as per standard (R)	WPS approval (A)	Non-destructive testing (R)	Calculation for accuracy (R)	Insulation Resistance (R)	IBR Certification as applicable (R)	Hydro test (R)	Material test certificate (A)
15. Cold junction compensation box	Y	Y	Y	Y					Y			
16. Orifice plate(BS-1042)	Y	Y	Y	Y *	Y	Y * *	Y * *			Y	Y * *	Y
17. Flow nozzle(BS-1042)	Y	Y	Y	Y *	Y	Y	Y			Y	Y	Y
18. Impact head type element	Y	Y	Y					Y				Y
19. Level transmitter/float type switch	Y	Y	Y	Y					Y	Y	Y	Y
20. Flue Gas analyser	Y	Y	Y	Y								
21. Dust emission monitors	Y	Y	Y	Y								
*Calibration to be carried out on one flow element of each type and size if calibration carried out as type test same shall not be repeated.												
** If applicable												

R-Routine Test A- Acceptance Test Y – Test applicable

Note:

1) Detailed procedure of Burn-in and Elevated Temperature test shall be as per Quality Assurance Programme in General Technical Conditions
2) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted along with relevant supporting documents.
3) Acceptance tests shall be carried out in presence of owner's representative.

CI.8. CONTROL VALVES AND ACTUATORS

CONTROL VALVE ACTUATORS AND ACCESSORIES.

TESTS / ITEMS	Make,model,tag (R)	Dimension®	Surface finish®	Heat Treatment®	Material Test Certificates®	IBR Certificates®	Hydraulic Test®	UT/Radiography for >900 lb rating®	MPI/DP®	Pressure Resistance®	Seat leakage®	Timeing Open/Close®	Linearity/Hysterisis®	Functional Test, review for make and TC of accessories®
CONTROL VALVE AND ACTUATOR														
Overall	Y	Y	Y			Y	Y				Y	Y	Y	Y
Body		Y	Y	Y	Y			Y	Y	Y				
Bonnet		Y	Y	Y	Y									
Trim		Y			Y			Y *						
Pneumatic actuator	Y	Y								Y				

R- Routine Test A - Acceptance Test Y - Test Applicable

Y* - UT on spindle dia >= 40 mm.

Note :

1) Detailed procedure of Burn-in and Elevated Temperature test shall be as per Quality Assurance Programme General Technical Conditions

2) This is an indicative list of tests/checks. The manufacture is to furnish a detailed Quality Plan indicating his practice & Procedure along with relevant supporting documents during QP finalisation for all item.

3) Acceptance tests shall be carried out in presence of owner's representative.

CI.9. ELECTRICAL ACTUATORS WITH INTEGRAL STARTER

ELECTRICAL ACTUATOR WITH INTEGRAL STARTER													
Test/Attributes Characteristics / ITEM/ COPONENT/ SUB SYSTEM ASSEMBLY/ TESTING	RPM ®	No Load Current ®	IR & HV Test®	Mounting Dimension®	All routine Test as per Standard &	Correct Phase Sequence®	Operation & Setting of limit Switch/Torque Switch®	Stall Torque/Current (A)	Hand Wheel operation/ Auto de clutch function (A)	Function of Aux. like Potentiometer, space heater, position indicator ®	EPT output ®	Grease leakage ®	Local/ Remote (Open-Stop-Close) Operation® Safety check (Single phasing, Phase correction, Tripping etc.) (A)
ELECTRICAL ACTUATOR WITH INTEGRAL STARTER(IS_9334)													
Motor	Y	Y	Y	Y	Y								
Final Testing	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Note:

1) Detailed procedure of Burn-in and Elevated Temperature test shall be as per Quality Assurance Programme in General Technical Conditions

2) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the practices and procedure adopted along with relevant supporting documents.

® - Routine Test (A) - Acceptance Test Y - Test applicable

E24: VFD

VFD MODULE				
ITEMS/COMPONENTS, SUB SYSTEM ASSEMBLY	ATTRIBUTES / CHARACTERISTICS			
	Visual & Dimensional checks	Make/Type/ Rating etc.	Final Inspection as ISS/IEC	Remarks
HT Breaker (IEC 56)	Y	Y	Y	
DC Reactor	Y	Y		
Transformer	Y	Y		For details refer table for LT Indoor Transformer & Auxiliary Transformer
Motor	Y	Y		For details refer separate table for Motor
VFD Panel	Y	Y		For details refer table for VFD Panel

Note:-

1. This is an indicative list of tests/checks. The manufacture is to furnish a detailed Quality Plan indicating the practices & Procedure followed along with relevant supporting documents during QP finalization.

Make of all major bought out Items will be subject to owner approval.

TYPE TEST REQUIREMENT

CHAPTER – 13

TYPE TEST REQUIREMENTS

13.00.00 General Requirements

13.00.01 The Bidder shall furnish the type test reports of all type tests as per relevant standards and codes as well as other specific tests indicated in this specification. If the bidder proposes a different standard/code from that indicated at table 13.02.00 below, same is acceptable provided the equivalence of the proposed standard is established by the bidder. A list of such tests are given for various equipment in table titled 'TYPE TEST REQUIREMENT FOR C&I SYSTEMS' at the end of this chapter and under the item Special Requirement for Solid State Equipments/Systems. For the balance equipment instrument, type tests may be conducted as per manufactures standard or if required by relevant standard.

(a) Out of the tests listed, the Bidder/ sub-vendor/ manufacturer is required to conduct certain type tests specifically for this contract (and witnessed by Owner or his authorized representative) even if the same had been conducted earlier, as clearly indicated subsequently against such tests.

(b) For the rest, submission of type test results and certificate shall be acceptable provided.

i. The same has been carried out by the Bidder/ sub-vendor on exactly the same model /rating of equipment.

ii. There has been no change in the components from the offered equipment & tested equipment.

iii. The test has been carried out as per the latest standards along with amendments as on the date of Bid opening.

(c) In case the approved equipment is different from the one on which the type test had been conducted earlier or any of the above grounds, then the tests have to be repeated and the cost of such tests shall be borne by the Bidder/ sub-vendor within the quoted price and no extra cost will be payable by the Owner on this account.

13.00.02 As mentioned against certain items, the test certificates for some of the items shall be reviewed and approved by the main Bidder or his authorized representative and the balance have to be approved by the Owner.

13.00.03 The schedule of conduction of type tests/ submission of reports shall be submitted and finalized during pre-award discussion.

13.00.04 For the type tests to be conducted, Bidder shall submit detailed test procedure for approval by Owner. This shall clearly specify test setup, instruments to be used, procedure, acceptance norms (wherever applicable), recording of different parameters, interval of recording precautions to be taken etc. for the tests to be carried out.

13.02.00 **TYPE TEST REQUIREMENT FOR C&I SYSTEMS**

S. No.	Item COL2	Test Requirement COL3	Standard COL4	Test to be specifically conducted COL5	Approval required on Test certificate COL6
1	Elect. Metering instruments	As per Standard (col4)	IS-1248	No	Yes
2	Transducers	As per Standard (col4)	IEC-60688, IS-12784	No	Yes

S. No.	Item COL2	Test Requirement COL3	Standard COL4	Test to be specifically conducted COL5	Approval required on Test certificate COL6
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,	No	Yes

S. No.	Item COL2	Test Requirement COL3	Standard COL4	Test to be specifically conducted COL5	Approval required on Test certificate COL6
			y-B)		
		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 Ten years from the date of bid opening. These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.

2.0 In case the Bidder is not able to submit report of the type test(s) conducted within last Ten years from the date of bid opening, or in case the type test report(s) are not found to be meeting the specification requirements, the 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-	No	Yes

S. No.	Item COL2	Test Requirement COL3	Standard COL4	Test to be specifically conducted COL5	Approval required on Test certificate COL6
			2-2 or equivalent		
		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 col 4	IS-10918	No	Yes
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 equivale	No	Yes

S. No.	Item COL2	Test Requirement COL3	Standard COL4	Test to be specifically conducted COL5	Approval required on Test certificate COL6
			nt		
		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 and Control Panels/Enclosures.	Degree of protection Test and Impact resistance test.	1. IP: IS/IEC 60529 or IS 13947	No	Yes

S. No.	Item COL2	Test Requirement COL3	Standard COL4	Test to be specifically conducted COL5	Approval required on Test certificate COL6
			2. IK: IEC 62262:2002		
	Flue Gas Analysers	Degree of protection Test	IS-13947	No	Yes
	Mercury Analysers	Degree of protection Test	IS-13947	No	Yes
	AAQMS 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 and Impact resistance test.	1. IP: IS/IEC 60529 or IS 13947 2. IK: IEC 62262:2002	No	Yes
	Junction Box	Degree of protection Test and Impact resistance test.	1. IP: IS/IEC 60529 or IS 13947 2. IK: IEC 62262:2002	No	Yes
	OPC data access server Data exchange server and Historical data access server	OPC Compliance testing		No	Yes (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

PLANT AUXILIARY SYSTEM

CHAPTER – 14

PLANT AUXILIARY SYSTEM

14.00.00 CONTROL AND INSTRUMENTATION FOR PLANT AUXILIARY SYSTEMS

14.00.01 Bidder shall provide complete Control and Instrumentation system with all accessories, auxiliaries and associated equipments and cables for the safe, efficient and reliable operation of the plant auxiliary systems as indicated under scope part at Part-A & Part B, Volume- V.

14.00.02 Bidder shall provide control system for safe, efficient and reliable operation of each of the plant auxiliary systems. The type of control system shall be as indicated under scope part at Part-A, Volume- V.

14.00.03 The control system shall provide safe operation under all plant disturbances and on component failure so that under no condition the safety of plant, personnel or equipment is jeopardized. Control system shall be designed to prevent abnormal swings due to loss of Control System power supply, failure of any Control System component, open circuit/short circuit etc.

14.00.04 The Control system shall include on-line self-surveillance, monitoring and diagnostic facility giving the details of the fault on the Human Machine Interface System (HMIS) as per standard and proven practice of the bidder.

For Fire Protection systems, the faults to be reported shall include fault in main & standby power supplies, sensor fault, Input/ Output card failure, Memory Status, Controller fault, failure of Communication/ Network links to PLCs, LAN etc. The diagnostic system shall ensure that the faults are detected before any significant change in any controller output has taken place.

14.00.05 The Control system shall generally operate in air conditioned area and shall be suitable for sustained operation for limited air conditioning failure.

14.00.06 PLC systems related to Fire Protection systems shall be interconnected with Fire Alarm panels also and redundant interface to DDCMIS from Fire Alarm panels is also envisaged. The alarm signals from PLC system & fire alarm system shall be provided to DDCMIS by interconnection of FAP at CER with DDCMIS. Hardwired signals shall be provided for interlock, protection & alarm from Fire alarm panels to main plant DDCMIS and respective off-site DDCMIS/PLC.

14.01.00 MICROPROCESSOR/ PROGRAMMABLE LOGIC BASED CONTROL SYSTEM

14.11.00 CONTROL & POWER SUPPLY SCHEME

14.11.01 General Requirements

The requirements of Electrical Power Supply system are specified herein on system basis. The Bidder shall be responsible for engineering and furnishing a complete and operational system fully meeting the intent and requirements of this specification including tender drawings. All equipment and accessories required for completeness of this system shall be furnished by the Bidder whether these are specifically mentioned herein or not. All the equipments and sub systems offered shall be from reputed experienced manufacturers. All system cabinets, enclosures, & distribution boards shall be manufactured, assembled, wired and fully tested as a complete assembly as per the requirements of this specification at the manufacturer's works.

24 V DC power supply system shall be provided as below for all Offsite packages:-

(A) 24V DC power supply system for PLC based control system shall comprise of two sets, each set shall consist of 1 x 100% Chargers, 1 x 100% Nickel - Cadmium batteries for one (1) hour duty, 1 X 100% DC distribution board. For specification of power supply system refer Sub Section, Volume--V, Part B, chapter 7 of Specification.

(B) For CHP's off site packages, Parallel redundant 230 V AC to 24 V DC convertor with automatic 50% load sharing & 125 % capacity shall be provided for 24 V DC power supply in each cubicle separately as per requirements.

The UPS power supply shall be extended to Parallel redundant 230 V AC to 24 V DC convertor thru redundant UPS feeders.

AC to DC convertor shall be SMPS based and shall have wide range of AC/DC input voltage (85-264 V AC & 90-350 VDC). It shall have the necessary diagnostic functions like indications for DC OK, automatic overload monitoring etc. The MTBF for the power supplies shall not be less than 500,000 hours (in Accordance with (IEC – 1709) with operating temp. from –25deg. C to 70 deg. C.

There should not be Diode oring for switch over. There should be separate power supply (230 V AC to 24 V DC convertor) with parallel redundant features with automatic 50% load sharing and indication & alarm on 230 V AC to 24 V DC convertor failure.

Pot free contacts shall be provided for 230 V AC/24 V DC convertor Fail alarm, 24 V DC under voltage alarm, 24 V DC over voltage alarm etc.

(C) For PLC based off site packages, UPS System shall consist of 2 x 100% parallel redundant chargers and inverters with input isolation transformers, 1 x 100%Ni Cd battery bank for one (1) hour, Bypass line transformers & voltage stabilizer, static switch manual bypass switch, 2 x 100% ACDB, and other necessary protective devices and accessories. The UPS shall consist of complete hardware and software for remote management.

The specifications for this configuration shall be as per Cl. No. 7.06.00 to 7.10.00 as a minimum.

(D) All interconnection hardware including cables to be provided.

14.12.00 **CONTROL CABINETS / PANELS/Desk**

14.12.01 The cabinets shall be IP-32 protection class with a suitable canopy at the top to prevent ingress of dripping water. The Bidder shall ensure that the packaging density of equipment in these cabinets is not excessive and abnormal temperature rise, above the cabinet temperature during normal operation or air- conditioning failure, is prevented by careful design. This shall be demonstrated to the Owner during the factory testing of the system. The Bidder shall ensure that the temperature rise is limited to 10 deg. C above ambient and is well within the safe limits for system components even under the worst condition as specified in Sub-section-basic Design criteria (Part-B, Volume- V) and specification requirements for remote I/O cabinets. Ventilation blowers shall be furnished as required by the equipment design and shall be sound proof to the maximum feasible extent. If blowers are required for satisfactory system operation, dual blowers with blower failure alarm shall be provided in each cabinet with proper enclosure and details shall be furnished with proposal. Suitable louvers with wire mesh shall be provided on the cabinet.

14.12.02 The cabinets shall be designed for front access to system modules and rear access to wiring and shall be designed for bottom entry of the cables.

14.12.03 The cabinets shall be totally enclosed, free standing type and shall be constructed with design criteria specified in Volume- V, Part B, Chapter 6, preferred height of the cabinet is 2200 mm. The cabinets shall be equipped with full height front and rear doors. The floor mounting arrangement for other cabinets shall be as required by the Owner and shall be furnished by the Bidder during detailed engineering.

14.12.04 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 more than 800 mm, double doors shall be provided.

14.12.05 Two spray coats of inhibitive epoxy primer-surface shall be applied to all exterior and interior surfaces. A minimum of 2 spray coats of final finish colour shall be applied to all surfaces. 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. The detailed of panels/control desk and finish colours for exterior and interior surfaces shall be as per Volume-V, Part B, Chapter 6.

14.12.06 Paint films which show sags, checks or other imperfections shall not be acceptable.

14.12.07 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.

14.12.08 Refer Volume- V, Part B, and Chapter-1 for grounding requirements & panel protection class.

14.12.09 The mimic shall be configured on the OWS and it shall be possible to control, monitor and operate the plant from the same.

14.24.00 RELAY BASED LOCAL CONTROL PANEL/DESK

Complete constructional details and features for Relay based local control panels shall be as specified in Cl.6.10 of Vol V, Part B, Chapter-6 in addition to the below technical details:

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 25x6 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 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**

Local control panel shall comply the features as specified in Vol. V, chapter-6 and above at Cl. No. 14.24.00.

PROVENNESS CRITERIA

6.3 Measuring instruments (primary & secondary), SWAS equipment offered for this package shall have at least one year's satisfactory operation prior to the date of Techno-Commercial bid opening in one power station having unit rating of 660 MW or above.

6.4 The 24 V DC modular charger offered for this package shall have at least one year's satisfactory operation prior to the date of Techno-Commercial bid opening in any industry or telecommunication application with a rating of 500 A or above.

6.5 The UPS system offered for this project, shall have atleast one(1) year's satisfactory operation prior to the date of Techno-Commercial bid opening, in one(1) power station for a rating of 105 KVA or above.

6.6 All other C&I equipment/ C&I system/Control systems/Sub systems and accessories etc., offered for this project shall have at least one year's satisfactory operation prior to the date of Techno-Commercial bid opening in one power station having unit rating of 660 MW or shall meet the provenness criteria/qualifying requirements indicated elsewhere in the specification.

6.9 The Bidder should have carried out Engineering of Control and Instrumentation System of the complete plant including offsite plants of at least one (1) unit of a coal fired power station having unit rating 660 MW or above which is in successful operation for a period of not less than one (1) year prior to the date of Techno-Commercial Bid opening. In case the Bidder does not have the engineering experience of the complete plant as described above, then the Bidder shall get the Control and Instrumentation engineering of the remaining plant area (s) done through any of its sub vendor(s) / supplier(s) or through Engineering firm(s) who meets the above requirement for the respective plant area(s).

6.10 Bidder shall furnish the required information / details / PTR to fully satisfy the owner regarding successful operation and high reliability of products/systems offered / furnished.

6.11 The bidder shall obtain & furnish the certification from his tie-up partners (as consortium or otherwise) that their design, engineering, procurement, manufacturing, erection, commissioning and shop test facility are adequate to meet the specified technical & performance/quality requirements for execution & commissioning of the package offered to the satisfaction of owner.

KKS TAGGING PHILOSOPHY

KKS NUMBERING PHILOSOPHY

For identifying (tagging) an instrument / equipment in Power plant KKS numbering scheme is used. The purpose is to assign a unique number to every equipment in the power plant. For C&I equipment unique number are to be provided up to the signal level so that a unique number Input / Output exist in DCS for every signal.

Normally KKS number is a 10 digit alpha-numeric code and is typically split into the following:

X	X	X	A	A	Y	Y	B	B	B

First three digits indicate the Sub-System. The Code for the major system are given as per **Annexure-**1.

Fourth and Fifth digits are the **Numerical Keys at System Code Level** and used to distinguish between main systems having same Alpha Codes.

Sixth and Seventh digits are the **Equipment / Apparatus / Measuring Circuit Code**. The code of various Equipment / Apparatus / Measuring Circuit is shown in **Annexure-2**

Eight, Nine and tenth digits are the **Numerical Keys at Equipment / Apparatus / Measuring Circuit Code** and used to distinguish between various instruments in the same sub-group. Numerical keys at System / Equipment / Apparatus / Measuring Circuit is shown in **Annexure-3**.

ANNEXURE-1

List of System / Sub-System Codes used in Power Plant:

1) Mill Reject Handling System: EUA

ANNEXURE-2

Standard Equipment Codes:

AA	Valves including drives, also hand operated
AB	Seclusions, Lock, Gates, Doors
AC	Heat Exchanger
AE	Turning, Driving, Lifting equipment
AF	Continuous conveyors, Feeders
AG	Generator Units
AH	Heating and Cooling Units
AK	Pressing and Packaging equipment
AM	Mixer, Stirrer
AN	Blower, Air Pumps / Fans, Compressor Units
AP	Pump Units
AT	Purification, Drying, Filter
AV	Combustion Equipment e.g. grates

Standard Apparatus Codes:

BB	Vessels and Tank
BF	Foundation
BG	Boiler Heating Surfaces
BN	Injector, Ejector
BP	Flow and throughput limitation equipment (Orifice)
BQ	Holders, Carrying Equipment, Support
BR	Piping, Ducts, Chutes, Compensator
BS	Sound Absorber
BU	Insulations, Sheatings

Standard Measuring Circuits Codes:

CD	Density
CE	Electrical Quantities
CF	Flow, throughput
CG	Distance, Length, Position
CK	Time
CL	Level

CM	Humidity
CQ	Analysis (SWAS)
CS	Speed, Velocity, Frequency
CT	Temperature
CY	Vibration, Expansion

ANNEXURE-3

Numerical Keys

A) Numerical Keys at System Code Level

i) Use 10, 20, 30... To distinguish between main systems having same Alpha Codes. Examples:

a) Main Steam (Left) and Main Steam (Right)

b) BFP – A/B/C

c) ID Fan – A/B, FD Fan A/B, AH – A/B

ii) For branch off from main system path having code say 10, keep the same alpha code and use 11, 12, 13 etc. Similarly for other branch off from main system path having code say 20, keep the same alpha code and use 21, 22, 23 etc and shall carry on further in the same way.

iii) If the branch off from main system / sub system path is used for some other system, where different alpha codes can be applied, then in that case the said branch line will be designated by the alpha codes of the system to which it is providing the input.

B) Numerical keys at Equipment Code level:

There are three numerical keys available for each type of equipment code. Following has been agreed upon considering present practice, better flexibility and ease in sorting.

i) Valves and Dampers --- *Equipment Code – AA*

		N1	N2 N3
Motorised *(on/off duty)*	-	*0*	*01 to 50*
Motorised (inching duty)	-	*0*	*51 to 99*
Pneumatic (Control)	-	*1*	*01 to 50*
Motorised (thyrestor Control)	-	*1*	*51 to 99*
Sol. Operated	-	2	01 to 99
(Open / Close duty (Valves, NRVs, Gate)			
Hydraulic	-	3	01 to 99

NRV (Without actuation)	-	4	01 to 99
Manual	-	5	01 to 99
Manual	-	6	01 to 99
Relief & Safety Valves	-	7	01 to 99
Reserve	-	8	01 to 99
Reserve	-	9	01 to 99

ii) Field Instruments

Field Transmitters & Analog Signals	-	0	01 to 99
Field Switches & Binary Signals	-	1	00 to 99
PG Test Point	-	4	00 to 99
Gauges	-	5	00 to 99
Automatic Turbine Tester (ATT)-HWR	-	2	00 to 99
(Reserved for protection Signals used by Hardwar)			

Example of Numerical Key Usage:

In line with the philosophy adopted for Valves / Dampers /instruments etc. pumps and fans in the main systems (having different system code) can be numbered as AP/N100 and as AP/N101, 102, ……. Where system code is same.

MANDATORY SPARES

List of Mandatory Spares

SL No.	PARTICULARS	Quantity/SET/LOT/ TYPE/RATING/DEFINITION
III.	**CONTROL & INSTRUMENTATION (MANDATORY SPARES)**	
1.00.00	**Description**	
1.00.01	**Measuring & Field Instruments**	
1.00.01.01	**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.	Nos-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	Nos.-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	Nos-10% of total number of instruments or a minimum of one number for each type, model, range etc. whichever is more
1.00.01.02	Temperature Elements and Thermowells	
(i)	Thermocouple/RTD elements	Nos-10% 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	Nos-10% for each type of temperature sensors or a minimum of one for each type & size, whichever is more
1.00.01.03	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.	Nos-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.
1.00.01.04	Process actuated switch Devices- As applicable for each package as per following:	Nos-10% of total nos. or 1 no. of each make, model, range and type whichever is more
	1. Temperature Switches	
	2. Differential pressure Switches	
	3. Pressure switches	
	4. Flow switches	
	5. Level Switches	
	6. Safety Protection Switches	
1.00.01.05	Local Gauges like temperature gauges, pressure gauges, differential Pressure gauges, flow gauges, flow meters with local display etc.	Nos-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
1.00.01.06	All type of Rota meters & Sight Flow Indicator.	Nos-1 no. of each range and type
1.00.01.07	PD type flow transmitters with local display.	Nos-1 no. of each type and model
1.00.01.08	Guided wave RADAR for Hot well application	1 no.
1.00.01.09	Guided wave RADAR for LP heaters	Nos-1 no. for each of the LP heaters
1.00.01.10	Impact head type flow element	Nos-20% or 2 nos. of each make and type, whichever is more
1.00.01.11	Ultrasonic type flow measurement	Nos-20% or 2 nos. of each make and type, whichever is more
1.00.01.12	Ultrasonic type level transmitter	Nos-10% of each type and length, including sensors
1.00.01.13	Any other instruments not indicated in the tender P&ID but required for control, monitoring and operation of the equipment/plant/systems	Nos-10% or 2 nos. of each type whichever is more

1.00.01.14	Level Gauges	Nos- 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.
1.00.01.15	Complete Electronic cards, PCB assembly and Power supply card assembly.	Nos-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.
1.00.05	**Microprocessor based control system**	
1.00.05.01	**Complete set including integral microprocessor based control system along with system & application software and special cables.**	Nos.-10% or 1 set of each type/model whichever is more
1.00.06	**Relay based Control Panels**	
1.00.06.01	LEDs for indicating lights	Nos.-100% of qty installed.
1.00.6.02	Control circuit fuses Semiconductor Fuses	Nos.-300% of installed of each type, current rating.
1.00.06.03	MCB/MCCB	Ten percent spare replacement of each current rating required shall be furnished
1.00.06.04	Cooling Fans of each type, model and rating.	20% or 2 nos. of each type and rating, (whichever is more).
1.00.06.05	Relays modules & contactors.	Nos.-20% spare of qty Installed of each type & rating.
1.00.06.06	Push buttons, ILPBs of each type.(complete with contact elements)	Ten (10) percent or 2 nos (whichever is more) of each type and color
1.00.06.07	Electric meter like Ammeters, Voltmeters etc.	Ten (10) percent or 2 nos (whichever is more) of each type
1.00.06.08	Control switches	5 nos. of each type and rating
1.00.06.09	Selector switches	1 no. of each type and rating
1.00.06.10	Any special meter	1 no. of each type and rating
1.00.06.11	Power supply modules.	Ten (10) percent or 2 nos (whichever is more) of each type
1.00.06.12	Control supply transformers	1 no. of each type and rating
1.00.09	**Erection hardware mounted in field, LIE & LIR**	
1.00.09.01	Instrument valves, manifold, fittings, impulse pipe, impulse tubes, drains pipes etc.	Nos-Ten (10) percent of each type, rating, model number and size of devices.
1.00.09.02	Condensate pots of each type & Size installed	Nos-Ten (10) percent of total number of Installed or four numbers whichever is higher .
1.00.09.03	Manifold 2 way, 3 way, 5 way valve manifolds	Nos-Ten (10) percent of each type & Size installed
1.00.09.04	Fittings	Nos-Twenty (20) percent of each type & Size installed
1.00.09.05	Purge meters	Ten (10) percent of each type & Size installed
1.00.09.06	Air Filter cum Regulator	Ten (10) percent of each type, make and model installed
1.00.09.07	MCB, and Power sockets used in LIE/LIR.	Ten (10) percent of each type
1.00.09.08	Fuses used in LIE/LIR.	Fifty (50) percent of each type of
	ELCTRICAL ACTUATORS WITH INTEGRAL STARTERS	**10% or 1 no. of each type, class, size and model whichever is more.**
1.00.24	**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 a 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.	
1.00.25	**CONTRACT-QUANTITIES**	

	The quantities & mandatory spares shall be as specified herein. Any other mandatory spares not listed above however required for any instrumentation item shall also be supplied by bidder. The final quantities may require addition/deletion during the contract stage. The Bidder shall furnish unit price for each mandatory spare under appropriate schedules which shall be used for adjusting the contract price in the event of addition/deletion from contract quantities specified herein.	
1.00.26	**DOCUMENTATION**	
	Bidder shall furnish detailed catalogue, part number and subassembly/assembly drawings with manufacturer's cross reference for each spare part. The data and information furnished shall be of nature and content as per owner's approval to enable owner procurement of these spare parts directly from the respective manufacturer.	
1.00.27	**Notes:**	
1	Wherever quantity has been specified percentage (%) the quantity of mandatory spares to be provided by the bidder shall be distributed into various ranges/size/rating/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 be rounded off to next higher whole	
2	Wherever the quantities have been indicated for each type, size, thickness, material, radius, range etc., these shall cover all items supplied and installed and the breakup for these shall be furnished in the bid.	
3	Incase spares indicated in the list are not applicable to the particular design offer by the bidder, the bidder should offer spares applicable to offered design with quantities generally in line with the approach followed in the above list.	
4	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	
5	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	

SECTION: I

SUB-SECTION: E

LIST OF ANNEXURES

SECTION: I

SUB-SECTION: E

ANNEXURE: I

LIST OF MAKES OF SUB-VENDOR ITEMS

S.No.	Description	Makes
1.	AIR WASHER & UAF*	HYDERABAD POLUTION CONTROL / SK SYSTEM / ADVANCE VENTILATION / DRAFT AIR / BLUE STAR / VOLTAS / STERLING WILSON & ROOTS COOLING SYSTEM / C. DOCTOR
2.	CENTRIFUGAL FAN	FLAKT / KRUGGER / DRAFT AIR / HYDERABAD POLUTION CONTROL / ADVANCE VENTILATION / PATEL AIR / NICOTRA/ SK SYSTEM / MARATHON / CB DOCTOR / SARLA
3.	AXIAL FLOW FANS/RE UNITS	HYDERABAD POLLUTION/ SK SYSTEM / ADVANCE VENTILATION / KRUGER / NICOTRA / MARATHON / FLAKT / CB DOCTOR/ PATEL AIR /SITAL
4.	CENTRIFUGAL WATER PUMP	BEST & CROMPTON / JYOTI / SAM TURBO / KBL / KSB / M&P / VOLTAS / BEACON-WEIR / WORTHINGTON / FLOWMORE / SULZER / BHARAT PUMPS & COMPRESSORS LTD / FLOWSERVE INDIA CONTROL PVT LTD / V-FLOW PUMPS & SYSTEMS CO
5.	INDUCTION MOTORS (LT)	SIEMENS / ABB / CGL / MARATHON / KEC / BHARAT BIJLEE / NGEF /JYOTI / LHP
6.	AIR FILTER	PUROLATOR / FMI / ANFILCO / TENACITY / JOHN FOWLER /SPECTRUM / AIR TECH / PUROMATIC
7.	INSULTATION MATERIAL	BEARDSHELL / K-FLEX / PARAMONT/ ARMAFLEX / SUPREME / LLOYDS / UP TWIGA /AEROCELL
8.	FIRE DAMPER	TSC / CARRYAIRE / RAVISTAR (SYSTEM AIR)
9.	BUTTERFLY VALVE	AUDCO / FOURESS / INTER VALVE / BDK / WEIR BDK / TYCO / CRANE PROCESS / KEYSTONE
10.	NON-RETURN VALVE	LEADER / H. SARKAR / FLUID LINE / HI -TECH / CRESENT / A V VALVES / BANKIM & COMPANY / SHIVADURGA
11.	GATE/GLOBE VALVES	CRESENT / BDK / AUDCO / FOURESS / KIRLOSKAR / SANT / BOMBAY METAL & ALLOYS / BANKIM / LEADER / H SARKAR / AV VALVES / VENUS PUMPS AND ENGG
12.	PIPING – ERW	SURYA ROSHNI / TISCO / DADU PIPES / INDUS TUBE / WELSPUN / TATA / BST / JINDAL / SAIL
13.	GI SHEETS FOR DUCTING	TISCO / INDIAN IRON & STEEL CO LTD. / RASHITRYA ISPAT NIGAM LTD. / ESSAR/ ISPAT INDUSTRIES / JSW STEEL / LLOYDS STEEL / BHUSHAN / TATA / SAIL / JINDAL
14.	HUMID STAT	JHONSON CONTROL / HONEYWELL / PENN
15.	PRESSURE GAUGE	GENERAL INST CONSORTIUM / BELL / H. GURU INST / WAAREE INSTRUMENTS / H. GURU IND / FORBES MARSHALL / MANOMETER / A.N. INST / GAUGES BOURDON / GLUCK / WIKA / ASHCROFT / BAUMER TECHNOLOGIES/PRECISION MASS PRODUCTS/ BOSE PANDA
16.	TEMPERATURE GAUGE	H. GURU IND/ H. GURU INST/ FORBES MARSHALL/DETRIVE INST & ELECTRONICS / PYRO ELECTRIC /TOSHNIWAL BROSS / WAREE INSTRUMENTS / A.N. INST / GOA INSTRUMENTS / WIKA/ ASHCROFT / H GURU (SI)/ BAUMER TECHNOLOGIES/ GAUGE BOURDON/ GOA THERMOSTAT/ BUDENBERG GAUGE/ PRECISION MASS PRODUCTS

17.	**LEVEL GAUGE**	GENERAL INSTRUMENTS / CHEMTROLS / SBEM, PUNE/ AUTOMAT MUMBAI /SIGMA / TOSHNIWAL / TECHNOMATIC / TELACO /LEVCON / D K INSTRUMENTS / PUNE TECHTROL / FLOW STAR/ BLISS ANAND
18.	**PRESSURE SWITCH / DP SWITCHES**	BELLS / DANFOSS / DK INSTRUMENTS/ DRESSER / SOR INC / VASU / SWITZER / INDFOSS / TRAFAG / GIC / ASHCROFT/ KASTURBA UDYOG/ BARKSDALE/ PRECISION MASS/ MITTAL REFRIGERATION
19.	**LEVEL SWITCH**	SBEM / BLISS ANAND / HI TECH / RAMAN INST / SIGMA / SOR INC / WAREE INST / LEVCON / DK INSTURMENT / V AUTOMAT /CHEMTROLS / SIMENS / FLOW STAR / TRAC/ NIVO CONTROLS/ PUNE TECHTROLS/ SAPCON INSTRUMENTS/ BAUMER TECHNOLOGIES/ GIC
20.	**Y / POT STRAINER**	MULTITEX / GREAVES COTTON / JAYPEE / SANT / OTOKLIN / GRAND PRIX / GUJARAT OTOLIFT / DS ENGG / SAROJINI ENTERPRISE / BHATIA ENGINEERING / FILTERATION ENGINEERS INDIA PVT LTD / SUNGOV ENGINEERING
21.	**CONTROL PANEL**	INDUSTRIAL CONTROL & APPLIANCE/ PYROTECH /POSITRONICS / CONTROL & SWITCHGEAR /SIEMENS / L&T /GE POWER /RITTAL / HOFFMAN
	ALSO REFER CUSTOMR SPECIFICATION SECTION C2	
NOTE		
	* Designed by C. Doctor / Blue Star / Voltas / Hyderabad Pollution Controls / SK System /Advance Ventilation / Draft Air / Sterling & Wilson / Roots cooling and fabricated by their approved fabricators.	
	Above sub-vendorS are also subjected to Customer approval during detailed engineering.	

SECTION-I

SUB SECTION –E

ANNEXURE-II

MANDATORY SPARE LIST
(COVERED IN UNPRICED SCHEDULE)

SECTION-I

SUB-SECTION-E

ANNEXURE-III

LIST OF TOOLS & TACKLES
AND
LIST OF COMMISSIONING SPARES
(COVERED IN UNPRICED SCHEDULE)

SECTION-I

SUB-SECTION-E

ANNEXURE-IV

DRAWINGS / DOCUMENTS SUBMISSION PROCEDURE

1. Bidder shall submit soft copy / hard copy / CD ROMs of all the finally approved drawings and O&M Manuals as required by Customer/ Customer's 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 during detailed engineering and bidder shall submit the same without any commercial/ delivery implications to BHEL/ Customer.
2. 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.
3. Bidder to submit soft copies of all the drawing and document along with quality plans for BHEL review and approval.
4. Editable copy of all the drawings and documents shall be provided.
5. The date of submission of drawing documents shall be considered as the date of submission of hard and soft copes whichever is later.
6. 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.
7. Vendor to come for meeting with the concerned dealing persons as per BHEL or customer requirement in a short notice.
8. 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.
    a. P&IDs.
    b. Equipment layout of Air washer and UAF along-with pumps, Ventilation duct layout etc.
    c. Piping layout drawing.
    d. Valve schedule, Instrument schedule, Cable Schedule etc,
    e. I/O list and drive list.
    f. Any other document/ drawing as required by BHEL/ customer

Other requirements

1. 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.
2. 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.
3. 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.

SECTION-I

SUB-SECTION-E

ANNEXURE-V

MASTER DRAWING LIST

MASTER DRAWING LIST FOR VENTILATION SYSTEM				
S. No.	BHEL DOCUMENT NO.	Title	Schedule submission date (No. of days)	Type of Document
1	PE-V0-510-554-A001	INSPECTION CATEGORISATION PLAN CUM SUB VENDOR LIST FOR VENTILATION SYSTEM	25	PRIMARY
2	PE-V0-510-554-A002	QUALITY PLAN OF AIR WASHER / UAF FOR VENTILATION SYSTEM	65	PRIMARY
3	PE-V0-510-554-A003	QUALITY PLAN OF CENTRIFUGAL PUMPS FOR VENTILATION SYSTEM	75	PRIMARY
4	PE-V0-510-554-A004	QUALITY PLAN OF CENTRIFUGAL FANS FOR VENTILATION SYSTEM	75	PRIMARY
5	PE-V0-510-554-A005	QUALITY PLAN OF AXIAL FLOW FANS & RE UNITS FOR VENTILATION SYSTEM	75	SECONDARY
6	PE-V0-510-554-A006	QUALITY PLAN OF MOTOR FOR VENTILATION SYSTEM	75	PRIMARY
7	PE-V0-510-554-A007	WRITE UP & CONTROL PHILOSOPHY FOR VENTILATION SYSTEM WITH SET POINTS	60	PRIMARY
8	PE-V0-510-554-A008	VENTILATION FAN SCHEDULE	75	PRIMARY
9	PE-V0-510-554-A009	DATA SHEET & GA FOR AIR WASHER & UAF ALONGWITH FAN AND PUMP FOUNDATION DETAILS FOR VENTILATION SYSTEM	80	PRIMARY
10	PE-V0-510-554-A010	DATA SHEET & GA FOR ROOF EXTRACTOR, AXIAL (EXHAUST AND SUPPLY AIR) FANS WITH FIXING ARRANGEMENT FOR VENTILATION SYSTEM	85	PRIMARY
11	PE-V0-510-554-A011	DATA SHEET & GA FOR VALVES (GATE VALVE, BUTTERFLY VALVE, CHECK VALVE, GLOBE VALVE ETC.) AND STRAINER FOR VENTILATION SYSTEM	90	SECONDARY
12	PE-V0-510-554-A012	DATA SHEET FOR INSULATION (THERMAL & ACCOUSTIC) FOR VENTILATION SYSTEM	45	SECONDARY
13	PE-V0-510-554-A013	DATA SHEET & GA FIRE DAMPER WITH ACTUATOR FOR VENTILLATION SYSTEM	50	SECONDARY
14	PE-V0-510-554-A014	DATA SHEET FOR INSTRUMENTS (PRESSURE GAUGE, TEMP GAUGE, LEVEL GAUGE, PRESSURE SWITCH, LEVEL SWITCH) FOR VENTILLATION SYSTEM	110	SECONDARY

15	PE-V0-510-554-A015	DATA SHEET OF PIPE FOR VENTILLATION SYSTEM	40	SECONDARY
16	PE-V0-510-554-A016	DATA SHEET OF GI AND MS SHEET FOR VENTILLATION SYSTEM	40	SECONDARY
17	PE-V0-510-554-A017	DATA SHEET & GA FOR FILTER FOR VENTILATION SYSTEM	45	SECONDARY
18	PE-V0-510-554-A018	DATA SHEET FOR MOTORS (A/W FAN, A/W PUMPS, UAF FAN, UAF PUMP, RE UNIT, SUPPLY AND EXHAUST AXIAL FAN) FOR VENTILLATION SYSTEM	90	SECONDARY
19	PE-V0-510-554-A019	GA OF PROPELLER FAN FOR VENTILLATION SYSTEM	50	SECONDARY
20	PE-V0-510-554-A020	TYPICAL DETAILS/ DRAWINGS OF DUCT FABRICATION / SUPPORT ARRANGMENT/ ERECTION / INSULATION OF DUCTING / PIPING & EQUIPMENTS PIPE ERECTION FOR VENTILATION SYSTEM	45	SECONDARY
21	PE-V0-510-554-A021	PID & SCHEME FOR AIRWASHER AND UAF UNIT FOR VENTILATION SYSTEM	30	PRIMARY
22	PE-V0-510-554-A022	AIR WASHER LAYOUT OUTSIDE "A ROW" SIDE ALONGWITH FOUNDATION DETAILS - TG BUILDING	65	PRIMARY
23	PE-V0-510-554-A023	AIR WASHER LAYOUT FOR "B-C BAY " SIDE ALONG WITH FOUNDATION DETAILS - TG BUILDING	80	PRIMARY
24	PE-V0-510-554-A024	VENTILATION DUCT LAYOUT FOR TG BUILDING - 'A' ROW SIDE AIR WASHER	65	PRIMARY
25	PE-V0-510-554-A025	VENTILATION DUCT LAYOUT FOR TG BUILDING - 'BC' BAY SIDE AIR WASHER	80	PRIMARY
26	PE-V0-510-554-A026	UAF LAYOUT ALONGWITH FOUNDATION DETAILS - ESP BUILDING.	90	PRIMARY
27	PE-V0-510-554-A027	VENTILATION DUCT LAYOUT FOR ESP BUILDING	60	PRIMARY
28	PE-V0-510-554-A028	LOCATION OF ROOF EXTRACTOR UNIT IN TG BUILDING ALONGWITH FIXING DETAILSFOR VENTILLATION SYSTEM	90	PRIMARY
29	PE-V0-510-554-A029	VENT. ARRANGEMENT FOR BATTERY ROOM.	80	PRIMARY
30	PE-V0-510-554-A030	VENT. ARRANGEMENT FOR VARIOUS AUXILIARY BUILDING.	110	SECONDARY

31	PE-V0-510-554-A031	DRIVE LIST & IO LIST (ANALOG AND BINARY) FOR VENTILATION SYSTEM	100	SECONDARY
32	PE-V0-510-554-A032	TECHNICAL DATASHEET FOR GRILLS/ DIFFUSER/ VOLUME CONTROL DAMPER	55	PRIMARY
33	PE-V0-510-554-A033	P.G/ DEMONSTRATION TEST PROCEDUREFOR VENTILLATION SYSTEM	120	SECONDARY
34	PE-V0-510-554-A034	O & M MANUAL FOR VENTILATION SYSTEM	150	SECONDARY
30	PE-V0-510-554-A035	CONTROL SCHEME / LOGIC DRAWING FOR VENTILATION SYSTEM	150	SECONDARY
31	PE-V0-510-554-A036	TECHNICAL DATASHEET, GA & TYPE TEST OF JUNCTION BOX	135	SECONDARY
32	PE-V0-510-554-A037	VALVE SCHEDULE FOR VENTILATION SYSTEM	60	SECONDARY
33	PE-V0-510-554-A038	HEAT LOAD CALCULATION FOR VENTILATION SYSTEM	30	PRIMARY
34	PE-V0-510-554-A039	LIST OF INSTRUMENTS / INSTRUMENT SCHEDULE WITH SET POINTS FOR VENTILATION SYSTEM	125	SECONDARY
35	PE-V0-510-554-A040	ELECTRICAL FEEDER LIST FOR VENTILATION SYSTEM	100	SECONDARY
36	PE-V0-510-554-A041	CABLE SCHEDULE FOR VENTILATION SYSTEM	130	SECONDARY
37	PE-V0-510-554-A042	CABLE INTER CONNECTION SCHEDULE FOR VENTILATION SYSTEM	150	SECONDARY
38	PE-V0-510-554-A043	FABRICATION CUM GA DETAILED DRAWING FOR BASE FRAME STRUCTURE FOR AIR WASHER UNIT & UAF UNIT	85	PRIMARY
39	PE-V0-510-554-A044	FABRICATION CUM GA DETAILED DRAWING FOR TANK SPRAY CHAMBER INCLUDING FIXING DETAILS FOR TANKS, PIPES, NOZZLES, MIST ELEMINATOR, AIR DISTRIBUTION PLATE ETC FOR AIR WASHER UNIT & UAF UNIT	85	PRIMARY
40	PE-V0-510-554-A045	FABRICATION CUM GA DETAILED DRAWING FOR FAN CHAMBER INCLUDING FIXING DETAILS FOR FANS AND ACCESSORIES FOR AIR WASHER UNIT & UAF UNIT	85	PRIMARY

41	PE-V0-510-554-A046	FABRICATION CUM GA DETAILED DRAWING FOR AIR WASHER CASING AND UAF CASING	85	PRIMARY

Note:

1. Bidder to furnish hard copies/soft copies for above drawings / documents as per the dwg. / documents distribution as per project requirement.
2. Drawings shall be prepared in Auto CAD and shall be shared with BHEL during detail engineering of review.
3. Bidder to follow the drawing submission schedule. The successful bidder shall depute his design personnel to BHEL's/ Customer's/ Consultant's office for across the table discussion for resolution of issues and to get documents approved within the stipulated time.
4. Every revised submission incorporating comments – within 7 days. The drawings/ documents submitted by vendor shall be complete in all respects with revised drawing submitted incorporating all comments along with Customer Response Sheet (CRS). Any incomplete drawing submitted shall be treated as non- submission with delays attributable to vendor's account.
5. Revision made by the bidder in any drawings and documents shall be highlighted by indicating the no. of revisions in a triangle without fail so that the minimum time is required by BHEL to review the drawings and documents. Drawings/ documents to be submitted for BHEL review / approval shall be under Revision A, B, C… etc. while drawings /documents to be submitted thereafter for customer's approval after purchaser's approval shall be under R-0, 1, 2, 3 …. etc.
6. Any other drawings and documents as required by BHEL / Customer / Consultant shall be furnished by the successful bidder during detail engineering stage for which no commercial implication shall be entertained by BHEL.
7. Detailed erection manual for each of the equipment as well as complete system supplied under this contract shall be submitted at least 3 months before the scheduled erection of the concerned equipment / component or along with supply of concerned equipment / component whichever is earlier.
8. The Field Quality Plan of bidder shall also be submitted by the successful bidder during detail engineering for customer's / consultant's approval. All comments made by customer/ consultant shall be incorporated by the successful bidder without any commercial and delivery implication.
9. All possible efforts shall be made by the bidder to get the approval of drawings and documents from BHEL / customer / consultant at the earliest and the documents prepared / generated by them or their sub-vendors shall be checked by their competent authority before submission to BHEL.
10. Primary documents shall be treated as basic Engineering documents for contractual purpose.
11. All drawings and documents including general arrangement drawing, data sheet, calculation etc. shall be furnished to BHEL during detailed engineering stage and shall include / indicate

the following details for clarity w.r.t. inspection, construction, erection and maintenance etc.: -

- All drawings and documents shall bear BHEL's title block and drawing / document number. However, BHEL's drawing / document numbering scheme shall be furnished to the successful bidder after the placement of L.O.I.

- All drawings and documents shall indicate the list of all reference drawings including general arrangement.

- All drawings shall include / show plan, elevation, side view, cross - section, skin section, blow - up view, all major self-manufactured and bought out items shall be labelled and included in BOQ / BOM in tabular form.

- All text/ numeric in the document / drawings to be generated by the successful bidder will be in English language only.

SECTION-I

SUB-SECTION-E

ANNEXURE-VI

FORMAT FOR OPERATION AND MAINTENANCE MANUAL

Project name :
Project number :
Package Name :
PO reference :
Document number :
Revision number :

Sl.no. & Sections	Description	Tick (√)if included in Manual			Remarks
		Yes	No	Not Applicable	
1.	**COVER PAGE**				
1.1	Project Name				
1.2	Customer/consultant Name				
1.3	Name of Package				
1.4	Supplier details with phone, FAX ,email address , Emergency Contact number				
1.5	Name and sign of prepared by , checked by & approved by				
1.6	Revision history with approval Details				
2.0	**INDEX**				
2.1	showing the sections & related page nos All the pages should be numbered section wise				
3.0	**DESCRIPTION OF PLANT/SYSTEM**				
3.1	Description /write up of operating principle of system equipment/ associated sub-systems & accessories/controls system , operating conditions, performance parameters under normal , start up and special cases				
3.2	Equipment list and basic parameter with Tag numbers				
3.3	Data sheets approved by Customer/for information and catalogues provided by original manufacturer				
3.4	Associated other packages and Interface /terminal points				
3.5	P&ID & Process Diagrams				
3.6	GA Layout drawings, As-built drawings , Actual photograph of items/system (Drawings of A2 & bigger sizes are to be attached in the last)				

Sl.no. & Sections	Description	Tick (√)if included in Manual			Remarks
		Yes	No	Not Applicable	
3.7	Single line/wiring diagrams				
3.8	Control philosophy /control write-ups				
4.0	**COMMISSIONING ACTIVITIES (IF NOT COVERED IN SEPARATE DOCUMENT I.E. ERECTION MANUAL, COMMISSIONING MANUAL)**				
4.1	Pre-Commissioning Checks				
4.2	handling of items at site				
4.3	Storage at site				
4.4	Unpacking & Installation procedure				
5.0	**OPERATION GUIDELINES FOR PLANT PERSONAL/USER/OPERATOR**				
5. 1	Interlock & Protection logic along with the limiting values of protection settings for the equipment along with brief philosophy behind the logic, drawings etc. to be provided.				
5. 2	Start up, normal operation and shut down procedure for equipments along with the associated systems in step by step mode. Valve sequence chart, step list, interlocks etc. with Equipment isolating procedures to be mentioned.				
5. 3	Do's & Don't of the equipments.				
5. 4	Safety precautions to be taken during normal operation. Safety symbols, Emergency instructions on total power failure condition/lubrication failure/any other condition				
5. 5	Parameters to be monitored with normal values and limiting values				
5. 6	Trouble shooting with causes and remedial measures				
5. 7	Routine operational checks, recommended logs & records				
5. 8	Changeover schedule if more than one auxiliary for the same purpose is given				
5. 9	Painting requirement and schedule				
5. 10	Inspection, repair , Testing and calibration procedures				
6.0	**MAINTENANCE GUIDELINES FOR PLANT**				

Sl.no. & Sections	Description	Tick (√)if included in Manual			Remarks
		Yes	No	Not Applicable	
	PERSONAL				
6.1	List of Special Tools and Tackles required for Overhaul/Trouble shooting including special testing equipment required for calibration etc.				
6.2	Stepwise dismantling and re-assembly procedure clearly specifying the tools to be used, checks to be made, records to be maintained, clearances etc. to be mentioned. Tolerances for fitment of various components to be given.				
6.3	Preventive Maintenance & Overhauling schedules linked with running hours/calendar period along with checks to be given				
6.4	Long term maintenance schedules especially for structural, foundations etc.				
6.5	Consumable list along with the estimated quantity required during commissioning, normal running and during maintenance like Preventive Maintenances and Overhaul. Storage/handling requirement of consumables/self-life.				
6.6	List of lubricants with their Indian equivalent, Lubrication Schedule, Quantity required for each equipment for complete replacement is to be given				
6.7	List of vendors & Sub-vendors with their latest addresses, service centers, Telephone Nos., Fax Nos., Mobile Nos., e-mail IDs etc.				
6.8	List of mandatory and recommended spare parts list				
6.9	Tentative Lead time required for ordering of spares from the equipment supplier				
6.10	Guarantee and warranty clauses				
7.0	**Statutory and other specific requirements considerations.**				
8.0	**List of reference documents**				
9.0	**Binding as per requirement**				

SECTION-I

SUB-SECTION-E

ANNEXURE-VII

SITE STORAGE AND PRESERVATION

SITE STORAGE AND PRESERVATION GUIDELINES

FOR

MECHNANICAL BOPs

(Doc No: PE-DC-SSG-A001 REV.00)



PROJECT ENGINEERING MANAGEMENT, POWER SECTOR

BHARAT HEAVY ELECTRICALS LIMITED-NOIDA

CONTENT

1 SCOPE OF THE DOCUMENT

2 PURPOSE OF STORAGE & PRESERVATION

3 MEASURES TO BE TAKEN FOR STORAGE AND PRESERVATION

- a) GENERAL STORAGE REQUIREMENTS
- b) GENERAL PRESERVATION REQUIREMENTS
- c) GENERAL INSPECTION REQUIREMENTS

4 TYPE OF STORAGE FOR VARIOUS EQUIPMENT

5. CONCLUSION

6. STACKING ARRANGEMENT FOR PLATES AND STRUCTURAL STEEL

1. SCOPE OF THE DOCUMENT

This guideline is prepared in intent to provide proper site storage and preservation of the Mechanical, Electrical and C & I items / equipment supplied under various bought out packages/items. This storage procedure shall be followed at different power plant sites by concerned agency for storage and preservation from the date of equipment received at site until the same are erected and handed over to the customer.

2. PURPOSE OF STORAGE & PRESERVATION

Many of the items may be required to be kept in stores for long period. It shall therefore be essential that proper methods of storage and preservation be applied so that items do not deteriorate, loose some of their properties and become unusable due to atmospheric conditions and biological elements.

3. MEASURES TO BE TAKEN FOR STORAGE, HANDLING & PRESERVATION

A. GENERAL STORAGE REQUIREMENTS

1) To the extent feasible, materials should be stored near the point of erection. The storage areas should have adequate unloading and handling facilities with adequate passage space for movement of material handling equipment such as cranes, fork lift trucks, etc. The storage of materials shall be properly planned to minimise time loss during retrieval of items required for erection.
2) The outdoor storage areas as well as semi-closed stores shall be provided with adequate drainage facilities to prevent water logging. Adequacy of these facilities shall be checked prior to monsoon.
3) The storage sheds shall be built in conformity with fire safety requirements. The stores shall be provided with adequate lights and fire extinguishers. ‘No smoking’ signs shall be placed at strategic locations. Safety precautions shall be strictly enforced.
4) Adequate lighting facility shall be provided in storage areas and storage sheds and security personnel positioned to ensure enforcement of security measures to prevent theft and loss of materials.
5) Adequate number of competent stores personnel and security staff shall be deployed to efficiently store and maintain the equipment / material.
6) Vendor shall compulsory make covered storage shed of minimum size of 15 feet x 15 feet for storage of valuable electrical/electronic items/instruments etc.
7) Vendor shall compulsory make office of size 10 feet x 10 feet for site engineer/staff along with facility of computer/laptop/printer for protocol preparation and submission to BHEL.
8) Alternately vendor can provide container of suitable size for sr no-06 and 07 purpose.
9) Vendor shall deploy one number Safety officer and one number Quality engineer during total E&C period. Failure for above BHEL shall deploy it and appropriate charges shall be deducted from

vendor due payments.

10. The equipment shall be stored in an orderly manner, preserving their identification slips, tags and instruction booklets, etc., required during erection. The storage of materials shall be equipment-wise. Loose parts shall be stored in sheds on racks, preserving the identification marks and tags in good condition. The group codes shall be displayed on the racks

11. At no time shall any materials be stored directly on ground. All materials shall be stored minimum 200 mm above the ground preferably on wooden sleepers

b) GENERAL PRESERVATION REQUIREMENTS

1. All special measures to prevent corrosion shall be taken like keeping material in dry condition, avoiding the equipment coming in contact with corrosive fluid like water, acid etc.

2. Materials which carry protective coating shall not be wrapped in paper, cloth, etc., as these are liable to absorb and retain moisture. The material shall be inspected and in case of signs of wear or damages to protective coating, that portion shall be cleaned with approved solution and coated with an approved protective paint. Complete record of all such observations and protective measures taken shall be maintained.

3. Generally equipment supplied at site are properly greased or rust protective oil is applied on machined/ fabricated components. However periodic inspection shall be carried out to ensure that protection offered is intact.

4. While handling the equipment, no dragging on the ground is permitted. Avoid using wire rope for lifting coated components. Use polyester slings (if possible) otherwise protective material (e.g. clothes, wood block etc.) should be used while handling the components with rope / slings

5. For Equipment supplied with finished paint, touch paint shall be done in case any surface paint gets peeled off during handling. Otherwise such surfaces shall necessarily be wrapped with polythene to avoid any corrosion. Further for equipment wherein finish coat is to be applied at site, site to ensure that equipment is received with primer coat applied.

6. It shall be ensured by periodic inspection that plastic inserts are intact in tapped holes, wherever applicable.

7. Pipes shall be blown with air periodically and it shall be ensured that there is no obstruction.

8. Silica gel or approved equivalent moisture absorbing material in small cotton bags shall be placed and tied at various points on the equipment, wherever necessary.

9. Heavy rotating parts in assembled conditions shall be periodically rotated to prevent corrosion/jamming due to prolonged storage.

10. All the electrical equipment such as motors, generators, etc. shall be tested for insulation resistance at least once in three months and a record of such measured insulation values shall be maintained.
11. Following preservatives/preservation methods can be used depending upon type of equipment

a. Rust preventive fluid (RPF)

b. Rust protective paints

c. Tarpaulin covers, in case of outdoor storage

d. De-oxy aluminate for weld-ments

c) GENERAL INSPECTION REQUIREMENTS

1. Period inspection of materials with specific reference to –

- Ingress of moisture and corrosion damages.

  Damage to protective coating.

- Open ends in pipes, vessels and equipment –
  - In case any open ends are noticed, same shall be capped.

2. Any damages to equipment / materials.

- In case of any damages, these shall be promptly notified and in all cases, the repairs / rectification shall be carried out.
- Any items found damaged or not suitable as per project requirements shall be removed from site. If required to store temporarily, they shall be clearly marked and stored separately to prevent any inadvertent use.

4. TYPE OF STORAGE FOR VARIOUS EQUIPMENT

The types of storage are broadly classified under the following heads:

i **Closed storage with dry and dust free atmosphere**. (C)

The closed shed can be constructed by using cold-rolled / tubular components for structure and corrugated asbestos sheets / galvanised iron sheets for roofing. Brick walls / asbestos sheets can be used to cover all the sides. The floor of the shed can be finished with plain cement concrete suitably glazed. The shed shall be provided with proper ventilation and illumination.



ii **Semi-closed storage**. (S)

The semi closed shed can be constructed by using cold-rolled / tubular components for structure and corrugated / asbestos sheets for roofing. The floor shall be brick paved. If required a small portion of sides can be covered to protect components from rainwater splashing onto the components.





iii Open storage (O)

The open yard shall be levelled, well consolidated to achieve raised ground with the provision of feeder roads for crane approach along with access roads running all sides. One part of the open yard shall be stone pitched, levelled and consolidated with raised ground suitable for storing / stacking heavier and critical components with due space to handle them by cranes etc . Adequate number of sleepers, concrete block etc. to be provided to make raised platforms to stack critical materials.

A separate yard to be identified as “scrap yard” slightly away from main open yard to store wooden/steel scraps, which are to be disposed off. This is required to avoid mix up with regular components as well as to avoid fire hazard.

Some of the components, which are having both machined & un-machined surfaces and are bulky, shall be stored in open storage area on a raised ground and suitably covered with water proof / fire retardant tarpaulin.



The equipment listed below shall be stored and inspected as per requirement mentioned in the table below.

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
Raw material /mechanical items like pipes, plates, structure sections etc.)				
1.	Steel pipes (lined/unlined)	S	Damage , paint, corrosion, rubber lining peeling	Provide end cap
2.	MS Plates	S	Damage, paint, corrosion	
3.	SS Plates	S	Damage	
4.	Non-metallic pipes	S	Damage, cracks	Provide end cap
5.	Stainless steel pipes	S	Damage ,	Provide end cap
6.	MS sections, beams	S	Damage, paint, corrosion	
7.	Cable trays	S	Damage, condition of preservations	
8.	Insulation sheets	S	Damage	
9.	Insulation	C	Damage, packing	
10.	Hangers Rods	S	Damage, paint, packing	
11.	Tubes	S	Damage, paint , packing	Provide end cap
12.	Hume pipes	O	Damage	
13.	Castings	O	Damage, paint, corrosion	
Fabricated mechanical items (pressure vessels, tanks etc.)				
14.	Pressure vessels (unlined)	O	Damage, paint, corrosion,	Covered nozzles
15.	Atmospheric storage tanks (unlined)	O	Damage, paint, corrosion	Covered nozzles

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
16.	Pressure vessels (lined)	S	Damage, paint, corrosion, rubber lining	
17.	Atmospheric storage tanks(lined)	S	Damage, paint, corrosion, rubber lining	
18.	Support structures	O	Damage , paint, corrosion	
19.	Flanges	C	Damage , paint, corrosion	
20.	Fabricated pipes	S	Damage , paint, corrosion	Provide end cap
21.	Vessels internals	C	Damage , paint, corrosion ,packing	
22.	Grills	S	Damage , paint, corrosion	
23.	Angles	S	Damage , paint, corrosion	
24.	Bridge mechanism/clarifier mechanism	O	Damage , paint, corrosion	
25.	Cranes, rails	S	Damage , paint, corrosion	
26.	Stair cases	O	Damage , paint, corrosion	
27.	Ladders/handrails	O	Damage , paint, corrosion	
28.	Fabricated ducts	S	Damage , paint, corrosion	
29.	Isolation Gates	O	Damage , paint, corrosion	
30.	Fabricated boxes/panels	S	Damage , paint, corrosion	
Mechanical components like valves, fittings, cables glands, spares etc.)				
31.	Valves	S	Damage , packing	

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
32.	Fittings	S	Damage , packing	Provide end cap
33.	Cable glands	C	Damage , packing	
34.	Tools & tackles	C	Damage , packing	
35.	Nut , bolts, washers,	C	Damage , packing	
36.	Gasket & Packings	C	Damage , packing	
37.	Copper tubes	C	Damage , packing, corrosion	Provide end cap
38.	SS tubing	C	Damage , packing	Provide end cap
Rotating assemblies (pumps, blowers, stirrers, fans, compressors etc.)				
39.	Pumps	S	Damage , packing, corrosion	Shaft rotation
40.	Blowers/Compressors	S	Damage , packing, corrosion	Shaft rotation
41.	Agitators/stirrers/radial launders	C	Damage , packing, corrosion	Shaft rotation
42.	Rollers for chlorine tonner mounting	C	Damage , packing, corrosion	
43.	Centrifuge	S	Damage , packing,	
44.	Gear box	C	Damage , packing, corrosion	
45.	Bearings	C	Damage , packing, corrosion	
46.	Fans	S	Damage , packing, corrosion	
47.	Dosing skids	S	Damage , packing, corrosion	
48.	Pump assemblies	S	Damage , packing, corrosion	
49.	Air washers(INTERNALS)	S	Damage , packing	
50.	Air conditioners (split)	C	Damage , packing	

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
51.	Elevators(CONTAINERIZED)	O	Damage , packing, corrosion	
52.	Chillers/VA machines	S	Damage , packing	
53.	Air handling Unit/Package unit	S	Damage , packing	
54.	Chlorinators & Evaporators	C	Damage , packing	
55.	Ejectors	C	Damage , packing	
56.	Electrolyser	C	Damage , packing	
Miscellaneous items like chain pulley blocks, hoists etc.				
57.	Chain pulley blocks	S	Damage, Packing	
58.	Electric hoists	S	Damage, Packing	
59.	Fire extinguishers	C	Damage, expiry date	
60.	Fork Lift Truck	S	Damage, Packing	
61.	Hydraulic Mobile Crane	O	Damage, Packing	
62.	Mobile Pick Up & Carry Crane	O	Damage, Packing	
63.	Motor boats	O	Damage, Packing	
64.	Safety showers	S	Damage, Packing	
65.	Diffusers/dampers	S	Damage, Packing	
Chemicals and consumables (acid, alkali, paints, oils, reagents and special chemicals)				
66.	Hydro Chloric Acid (HCl)	Store in canes/ storage tank in dyke area	Date of production/ leakage/fumes	hazardous chemical
67.	Sulphuric acid (H_2SO_4)	Store in canes/ storage tank in dyke area	Date of production/ leakage/fumes	hazardous chemical

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
68.	Sodium hydroxide (NaOH)	Store in canes/ storage tank in dyke area	Date of production/ leakage/ fumes/ breather	hazardous chemical ,breather to be checked for air ingress
69.	Sodium hypo chlorite	To be stored under shed	Date of production/ leakage/ fumes	hazardous chemical ,self-life normally 15-30 days after which strength of chemical decays
70.	Ammonia	S	Date of production/ leakage/ fumes	Store in closed storage tanks, hazardous chemical
71.	CW treatment chemicals	S	Date of production , Self-life	Store in closed canes
72.	RO/UF cleaning chemicals	S	Date of production , Self-life	Store in closed canes
73.	Lime	C	Damage to packing , seepage	Prevent moisture, rain
74.	Alum bricks	C	Damage to packing	Prevent moisture, rain
75.	Poly electrolyte	S		Store in closed storage tanks
76.	Laboratory chemicals(powder)	C	Damage, Packing self-life	
77.	Laboratory chemicals(liquid)	C	Damage, Packing self-life	
78.	Lubrication oils	C	Leakage	
79.	Paints	S	Leakage ,air tightness	
80.	Sand	O	Damage of packing	No hooks
81.	Salt (NaCl)	C	Damage of packing, water ingress	Prevent moisture, rain
82.	Anthracite	S	Damage of packing	
83.	Activated carbon	S	Damage of packing	

Sl. No.	**Description of the equipment**	**Type of Storage**	**Check for**	**Remarks**
84.	Thermal insulation	S	Damage of packing	
85.	Cement	C	Damage of packing	Prevent moisture, rain
86.	Gravels	O	Damage of packing	
87.	ION exchange resins	C	Damage , packing	Refer manufacturer guidelines
88.	RO membranes	C	Damage , packing	Refer manufacturer guidelines
89.	UF membranes	C	Damage , packing	Refer manufacturer guidelines
90.	Cleaning chemicals	C	Damage , packing	Refer manufacturer guidelines
91.	Chemicals for analysers/calibration	C	Damage , packing	Refer manufacturer guidelines
Electrical and C & I items (motors, cables etc.)				
92.	Motors	C	Damage , packing	
93.	Cable drums	O	Damage	
94.	Control Panel /control desk, UPS ,JB	S	Damage, Packing	
95.	Instruments(gauges/analysers)	C	Damage	
Special items		As per Manufacturer's item, like Hydrogen cylinders, Ozonator, Analyser, Chlorine dioxide generators etc.		

5. CONCLUSION

Concerned storage agency at site should make sure that loss in equipment performance and wear & tear are minimised through proper storage and preservation. The above are broad guidelines and cover major equipment / materials. However specific storage practices shall be followed as per manufacturer recommendation. All the necessary measures even in addition to the ones mentioned above, if found necessary, should be taken to achieve the objective.

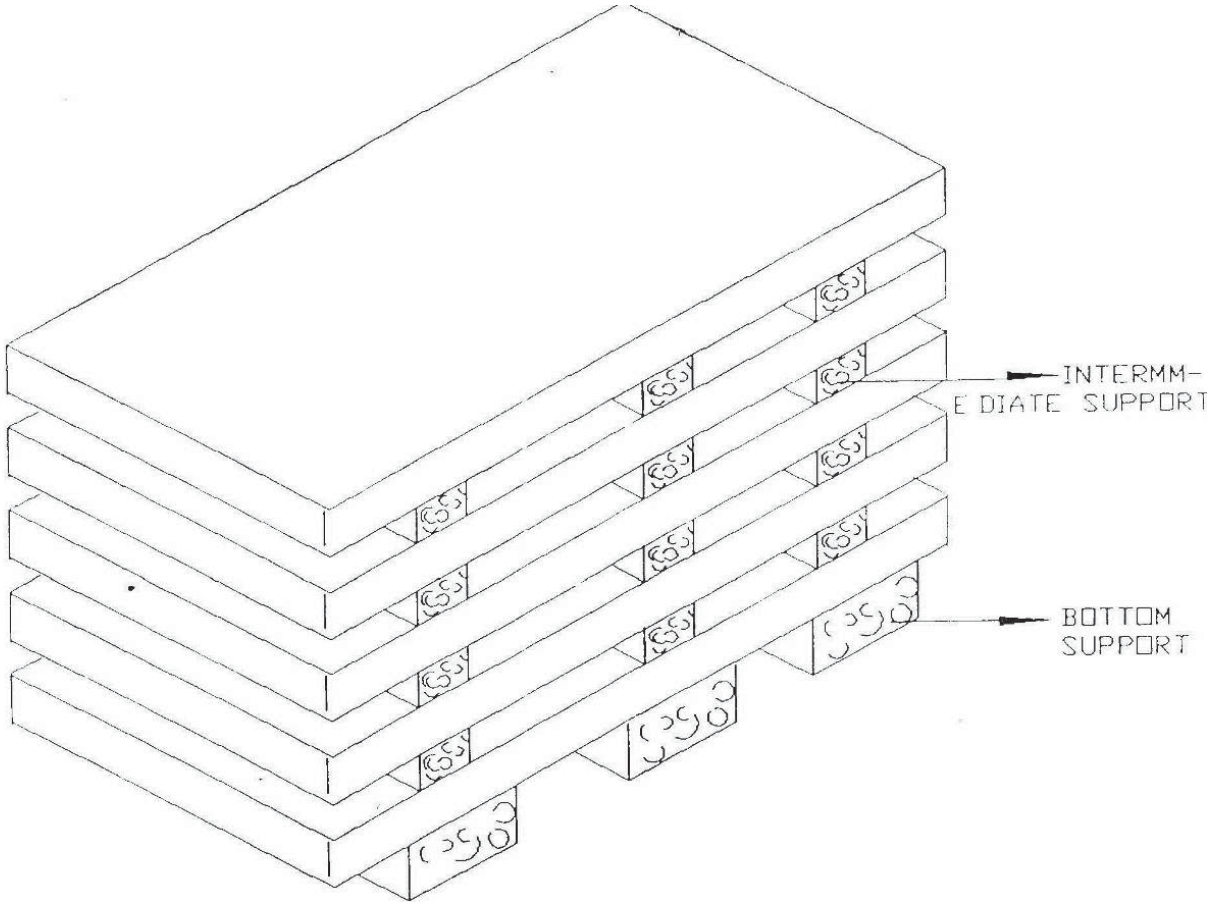


Figure – 1 – PLATE STACKING ARRANGEMENT

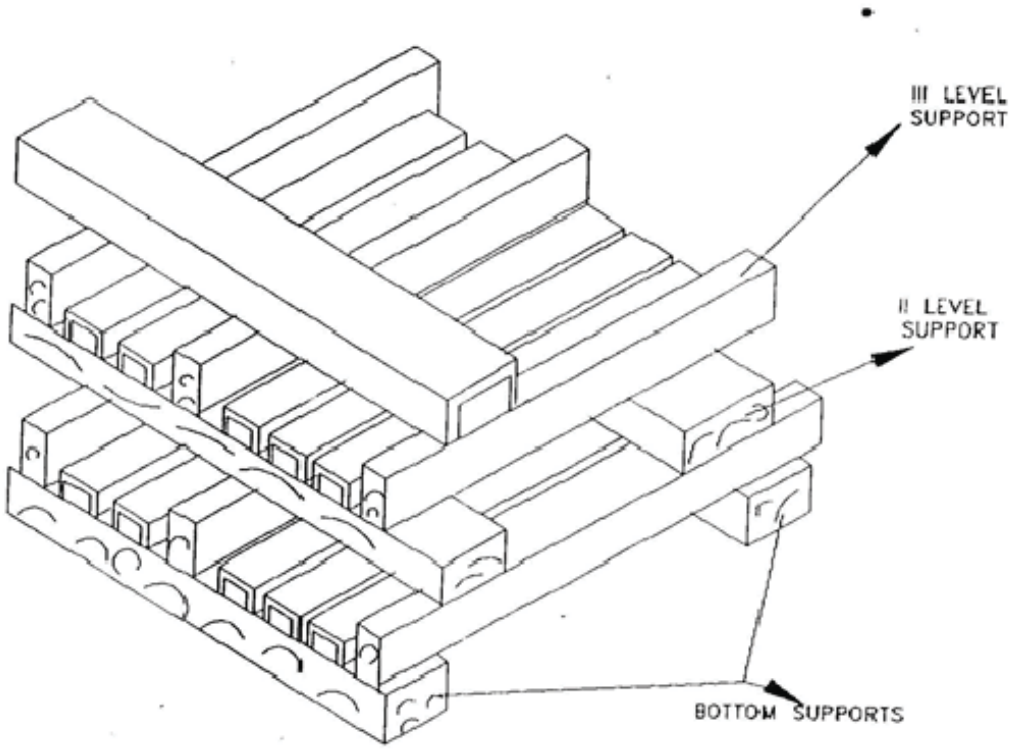


Figure – 2 – STRUCTURAL STEEL STACKING ARRANGEMENT

SECTION-I

SUB SECTION E

ANNEXURE-VIII

PAINTING & COLOUR SCHEME
(PLEASE REFER SECTION C2-B)

SECTION-I

SUB SECTION E

ANNEXURE-IX

PACKING PROCEDURE

(REFER SUB-SECTION C2-B)

SECTION-II

SECTION-II

SUB-SECTION-1

INSPECTION AND TESTING

1.01.00 Inspection and Tests during Manufacture.

1.01.01 The method and techniques to be used by the Bidder for the control of quality during manufacture of all plant and equipment shall be agreed with the Owner.

1.01.02 The Owner's general requirements with respect to quality control and the required shop tests are set out elsewhere in this specification.

1.01.03 Before any item of plant or equipment leaves its place of manufacture the Owner shall be given the option of witnessing inspections and tests for compliance with the specification and related standards.

1.01.04 Advance notice shall be given to the Owner as agreed in the Contract, prior to the stage of manufacture being reached, and the piece of plant must be held at this stage until the Owner has inspected the piece, or has advised in writing that inspection is waived. If having consulted the Owner and given reasonable notice in writing of the date on which the piece of plant will be available for inspection, the Owner does not attend the Bidder may proceed with manufacture having forwarded to the Owner duly certified copies of his own inspection and test results.

The owner's representative shall have at all reasonable times access to bidder's or his sub-vendor's premises and shall have power to inspect/ examine materials and workmanship or equipment under manufacture.

The Bidder shall forthwith forward to the engineer duly certified copies of the Test Certificates in six copies (one to the Purchaser and five to the Consulting Engineer) for approval. Further nine (9) copies of Shop Test Certificates shall be bound with Instruction Manuals referred to elsewhere.

For electrical equipment, routine tests as per relevant IS spec are to be carried out on all equipment. Type tests are also to be carried out on selected equipment as detailed in the specs of concerned electrical equipment.

1.01.05 Under no circumstances any repair or welding of castings be carried out without the consent of the Engineer. Proof of the effectiveness of each repair by radiographic and/or other non-destructive testing technique, shall be provided to the Engineer.

1.01.06 All the individual and assembled rotating parts shall be statically and dynamically balanced in the works.
Where accurate alignment is necessary for component parts of machinery normally assembled on site, the Bidder shall allow for trial assembly prior to despatch from place of manufacture.

1.01.07 All materials used for the manufacture of equipment covered under this specification shall be of tested quality. Relevant test certificates shall be made available to the Purchaser. The certificates shall include tests for mechanical properties and chemical analysis of representative material. Equipment or parts coming under any statutory

Regulations shall be certified by a Competent Authority under the regulations in the specified format.

1.01.08 All pressure parts connected to pumping main shall be subjected to hydraulic testing at a pressure of 150% of shut-off head for a period not less than one hour. Other parts shall be tested for one and half times the maximum operating pressure, for a period not less than one hour.

1.01.09 All necessary non-destructive examinations shall be performed to meet the applicable code requirements.

1.01.10 All welding procedures adopted for performing welding work shall be qualified in accordance with the requirements of Section-IX of ASME code or IBR as applicable. All welded joints for pressure parts shall be tested by liquid penetrant examination according to the method outlined in ASME Boiler and Pressure Vessel code. Radiography, magnetic particle examination magnuflux and ultrasonic testing shall be employed wherever necessary/ recommended by the applicable code. At least 10% of all major but welding joints shall be radiographed unless otherwise stipulated.

Statutory payments in respect of IBR approvals including inspection shall be made by the bidder. Bidder's scope shall include to preparation of all necessary documents, co-ordination and follow-up for above approval. Owner shall only forward assistance/endorsement of documents /design /drawings /reports/records to be submitted for approval as stipulated/ required by Statutory Authorities till registration of the unit and clearance for commercial operation.

1.02.00 Performance Tests at Site

1.02.01 The full requirements for testing the system shall be agreed between the Owner and the Bidder prior to Award of Contract. The completely erected System shall be tested by the Bidder on site under normal operating conditions. The Bidder shall also ensure the correct performance of the System under abnormal conditions, i.e. the correct working of the various emergency and safety devices, interlocks, etc.

1.02.02 The Bidder shall provide complete details of his normal procedures for testing, for the quality of erection and for the performance of the erected plant. These tests shall include site pressure test on all erected pipe work to demonstrate the quality of the piping and the adequacy of joints made at site.

1.02.03 The Bidder shall furnish the quality procedures to be adopted for assuring quality from the receipt of material at site, during storage, erection, pre-commissioning to tests on completion and commissioning of the complete system/equipment.

1.03.00 For details of specific tests required on individual equipment refer to respective section of this specification.

All Statutory testing / clearance is in Bidder's scope including payment of all fees, etc. as required

QAP FORMAT

BHARAT HEAVY ELECTRICALS LIMITED

CORPORATE QUALITY ASSURANCE

PROJECT: SYSTEM :

VENDOR : ITEM :

SL NO	COMPONENT /OPERATION OPERATIONS	CHARACTERISTICS CHECKED	CATEGORY	TYPE /METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11

Legend: 1. BHEL 2. Vendor 3. Sub-Vendor

QP No	CQS/SQP/31	Signature	Date			
	Rev		Name			
Page No	1 of 1		Party	Customer/Consultant	Bhel	Vendor

SECTION: II

SUB SECTION: 2

LIST OF DOCUMENTS TO BE SUBMITTED WITH BID

BIDDER SHOULD SUBMIT THE SIGNED AND STAMPED COPY OF THE FOLLOWING DOCUMENTS:

1. Compliance cum confirmation certificate
2. Guaranteed power consumption
3. Un priced format for Ventilation package
    a. Unpriced format for Main package, mandatory spares, tools and tackles and commissioning spares on BHEL e-procurement portal.
4. Deviation schedule /No deviation certificate in attached format 'Deviation sheet (Cost of withdrawal)'.
5. Pre-bid clarification schedule and signed copy of technical corrigenda, if any.

SECTION: II

SUB SECTION: 3

COMPLIANCE CUM CONFIRMATION CERTIFICATE

COMPLIANCE CUM CONFIRMATION CERTIFICATE

The bidder shall confirm compliance with following by signing / stamping this compliance certificate (every sheet) and furnish same with the offer.

a) The scope of supply, technical details, construction features, design parameters etc. shall be as per technical specification & there are no exclusions, other than those mentioned under "exclusion and those resolved as per 'Schedule of Deviations', with regard to same.

b) There are no other deviations w.r.t. specifications other than those furnished in the 'Schedule of Deviations'. Any other deviation, stated or implied, taken elsewhere in the offer stands withdrawn unless specifically brought out in the 'Schedule of Deviations'

c) Bidder shall submit QP in the event of order based on the guidelines given in the specification & QP enclosed therein. QP will be subject to BHEL / CUSTOMER approval & 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. This is within the contracted price without any extra implications to BHEL after award of the contract.

d) All drawings/ data-sheets / calculations etc. submitted along with the offer shall not be taken cognizance off.

e) The offered materials shall be either equivalent or superior to those specified in the specification & shall meet the specified / intended duty requirements. In case the material specified in the specifications is not compatible for intended duty requirements then same shall be resolved by the bidder with BHEL during the pre-bid discussions, otherwise BHEL / Customer's decision shall be binding on the bidder whenever the deficiency is pointed out.

   For components where materials are not specified, same shall be suitable for intended duty, all materials shall be subject to approval in the event of order.

f) The commissioning spares shall be supplied on 'As Required Basis' & prices for same included in the base price itself.

g) All sub vendors shall be subject to BHEL / CUSTOMER approval in the event of order.

h) Guarantee for plant/equipment shall be as per relevant clause of GCC / SCC / Other Commercial Terms & Conditions

i) In the event of order, all the material required for completing the job at site shall be supplied by the bidder within the ordered price even if the same are additional to approved billing break up, approved drawing or approved Bill of quantities within the scope of work as tender specification. This clause will apply in case during site

commissioning, additional requirements emerges due to customer and / or consultant's comments. No extra claims shall be put on this account

j) Schedule of drawings submissions, comment incorporations & approval shall be as stipulated in the specifications. The successful bidder shall depute his design personnel to BHEL's / Customer's / Consultant's office for across the table resolution of issues and to get documents approved in the stipulated time.

k) As built drawings shall be submitted as and when required during the project execution.

l) The bidder has not tempered with this compliance cum confirmation certificate and if at any stage any tempering in the signed copy of this document is noticed then same shall be treated as breach of contract and suitable actions shall be taken against the bidder.

m) Successful bidder shall furnish detailed erection manual for each of the equipment 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.

n) 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.

o) 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.

SECTION: II

SUB SECTION: 4

PRE-BID CLARIFICATION SCHEDULE

PRE-BID CLARIFICATION SCHEDULE

S. NO.	SECTION/CLAUSE/PAGE NO.	STATEMENT OF THE REFERRED CLAUSE	CLARIFICATION REQUIRED

SECTION: II

SUB SECTION: 5

NO DEVIATION CERTIFICATE
(REFER ANNEXURE-II OF GCC REV 07)

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. Cost of withdrawal of deviation will be applicable on the basic price (i.e. excluding taxes, duties & freight) only.
2. All the bidders have to list out all of their Technical & Commercial Deviations (if any) in detail in the above format.
3. Any deviation not mentioned above and shown separately or found hidden in offer, will not be taken cognizance of.
4. 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. In absence of same, such deviation (s) shall not be considered and offer shall be considered in total compliance to NIT.
5. Bidder shall furnish price copy of above format along with price bid.
6. The final decision of acceptance/ rejection of the deviations quoted by the bidder shall be at discretion of the Purchaser.
7. Bidders to note that any deviation (technical / commercial) not listed in above and asked after Part I opening shall not be considered.
8. For deviations w.r.t. Credit period, Liquidated damages, Firm prices if a bidder chooses not to give any cost of withdrawal of deviation loading as per Annexure-VII, 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.
9. Any deviation mentioned in priced copy of this format, but not mentioned in the un-priced copy, shall not

be considered.
10. 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.
11. Cost of withdrawal is to be given separately 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.
12. In case nature of cost of withdrawal (positive/negative) is not specified it shall be assumed as positive.
13. In case of discrepancy in the nature of impact (positive/ negative), positive will be considered for evaluation and negative for ordering.

SECTION: II

SUB SECTION: 6

GUARANTEED POWER CONSUMPTION (GPC)

1 X 800 MW YAMUNA NAGAR TPS						
VENTILATION SYSTEM						
GUARANTEED POWER CONSUMPTION FIGURES						
S.NO.	DESCRIPTION OF EQUIPMENT	NO OF EQUIPMENT		TOTAL GUARANTEED POWER CONSUMPTION FOR EACH EQUIPMENT AT MOTOR INPUT TERMINAL AND CONTROL PANEL (IN KW)	DUTY FACTOR	TOTAL KW
		WORKING	STANDBY			
		3A	3B	4	5	6=3Ax4x5
A	**VENTILATION SYSTEM FOR TG BUILDING**					
i	Centrifugal Fan for air washers Unit.	8	0		1	
ii	Centrifugal Pumps for circulation of water in spray chamber of above air washers Unit.	4	4		1	
iii	Roof Extractor of cap. 50,000 CMH.	13	0		1	
B	**VENTILATION SYSTEM FOR ESP BUILDING**					
i	Centrifugal Fan for UAF Unit.	2	0		1	
ii	Centrifugal Pumps for circulation of water in spray chamber of above UAF Unit.	2	2		1	
				TOTAL (KW)		

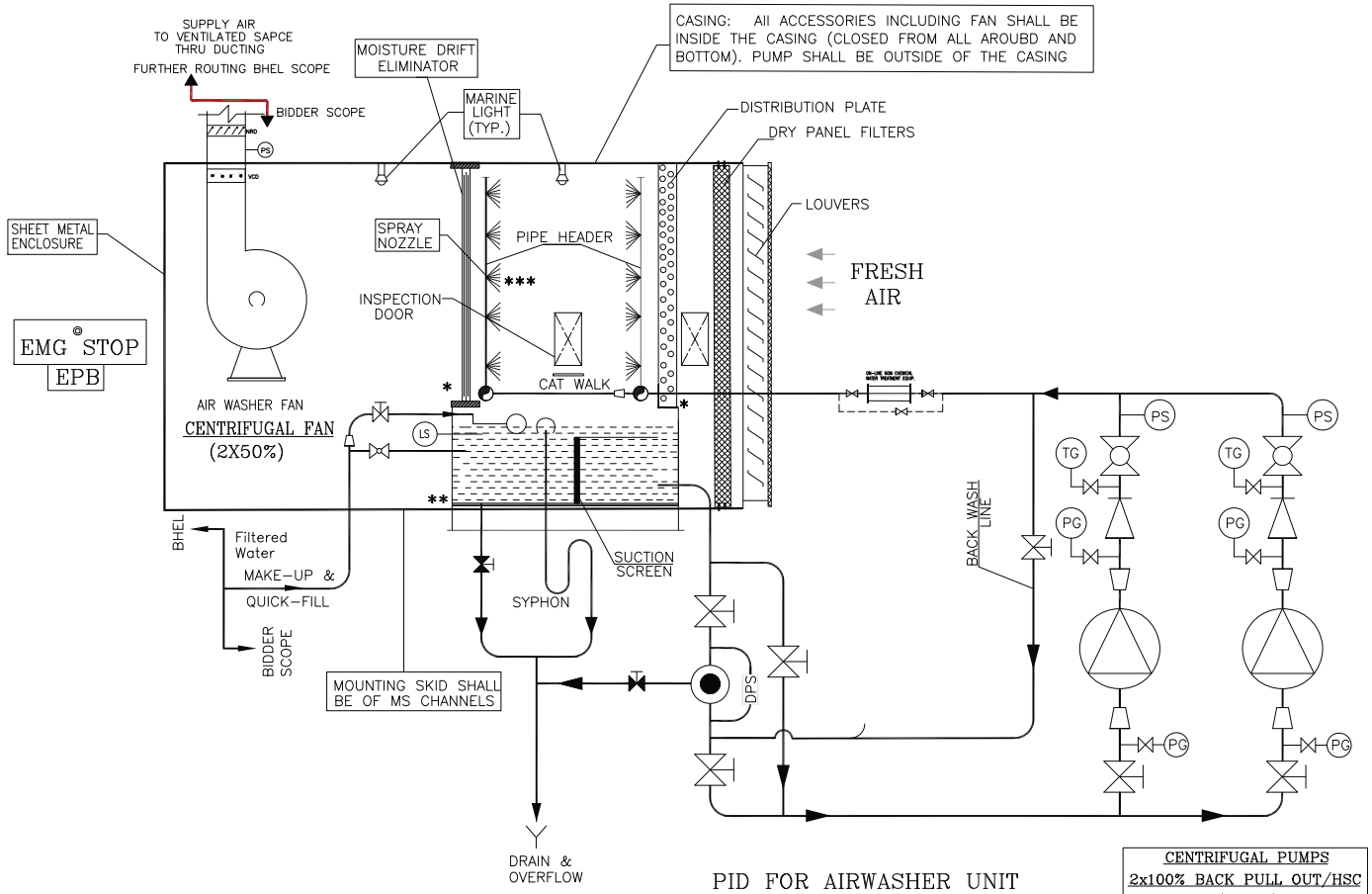
Note: Estimated power consumption (EPC) figure for the system (for working drives only) has been considered as **625 kW**. So long bidder's quoted guaranteed power consumption (GPC) above remains within this EPC, there will be no technical loading of bid on power consumption for evaluation. However, if bidder's quoted GPC exceeds EPC, there shall be technical loading of bid for evaluation **@ Rs 5,50,000 per kW** of additional power over EPC.

Bidder's guaranteed power consumption at motor input terminals (not shaft power) 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 **@ Rs 5,50,000 per kW** shall be levied on vendor.

SECTION: II

SUB SECTION: 7

TENDER DRAWINGS



PID FOR AIRWASHER UNIT

LEGEND: –

SYMBOL	DESCRIPTION	LOCATION
	GATE VALVE	AS PER PID
	GATE VALVE (NORMALLY CLOSED)	AS PER PID
	GLOBE VALVE	AS PER PID
	CHECK VALVE (NON-RETURN VALVE)	EACH PUMP OUTLET
	POT STRAINER	AT PUMP SUCTION HEADER
	VOLUME CONTROL DAMPER	FAN OUTLET
	CENTRIFUGAL PUMP	AS PER PID
	PRE FILTER	AS PER PID
PG	PRESSURE GAUGE	IN/OUT DISCHARGE OF PUMP.
PS	PRESSURE SWITCH	OUTLET OF PUMP & FAN
LS	LEVEL SWITCHS (LLS & HLS)	AWU TANK
	FLOAT VALVE	AWU TANK
	REDUCER	AS PER PID
	SCOPE OF SUPPLY	AS PER PID
	CENTRIFUGAL FAN	AS PER PID
DPS	DIFFERENTIAL PRESSURE SWITCH	ACROSS POT STRAINER
TG	TEMPERATURE GAUGE	OUTLET OF PUMP.

* The mist eliminator frame and the air distribution plate frame shall be located within the tank frame. This shall enable the water drooping down the respective frames directly into the tank, thereby avoiding leakages.

** Width of tank of Air washer shall cover complete width of Air washer so that there is no spillage of water and water falling from spray nozzles falls back into the tank. Necessary covering (using GI sheets) on air washer panels besides spray nozzles shall be provided to further stop spillage of water.

*** Uniform distribution of water through each spray nozzle shall be ensured in the Air washer spray section. Difference in pressure in spray nozzles due to head difference shall be corrected by using different sizes of nozzles/pipe size adjustment suitably.

CENTRIFUGAL PUMPS
2x100% BACK PULL OUT/HSC
(1W+1S)

THIS P&ID IS INDICATIVE AND FOR TENDER PURPOSE ONLY

GENERAL NOTES:
1. SATURATION EFFICIENCY OF AWU SHALL BE 90% MINIMUM.
2. ALL PIPES FOR AWU SHALL HEAVY GRADE AS PER IS: 1239 PART–I UPTO 150NB, IS 3589 FOR PIPE ABOVE 150 NB AND FITTINGS SHALL BE AS PER IS: 1239 PART–II.
3. GI LOUVERS (FIXED BLADE TYPE) SHALL BE COMPLETE WITH GI BIRD SCREEN
4. ALL EQUIPMENTS DRAIN SHALL BE TERMINATED TO NEAREST FLOOR DRAIN.
5. IN THE AWU TANK LEVEL SWITCH SHALL BE PROVIDED FOR ALARM/ TRIP.
6. CAT WALK OF 600mm WIDE SHALL BE PROVIDED.
7. SIZE OF INSPECTION DOOR: 600mm x 700 mm (H)
8. FIRE DAMPERS (MOTORISED) SHALL BE PROVIDED OPEN/CLOSE LIMIT CONNECTED TO THE DCS IN THE SUPPLY DUCT TO MCC/SWITCHGEAR ROOM AND CABLE SPREADER ROOM.
9. EMERGENCY PUSH BUTTON (EPB) SHALL BE PROVIDED FOR CENTRIFUGAL FAN FOR EACH AWU FOR EMERGENCY STOP.
10. GI PIPES HEAVY CLASS FOR AIR WASHER SHALL BE PROVIDED FOR SPRAY SYSTEM.
11. ALL AIR WASHER CASING TANK, FAN, COMPONENT ACCESSORIES SHALL HAVE SURFACE CORROSION PROTECTION PAINTING AS PER SPECIFICATION.
12. NECESSARY HEIGHT DIFFERENCE BETWEEN PUMP INLET AND MINIMUM WATER LEVEL IN TANK SHALL BE MAINTAINED SO THAT PUMP IS ALWAYS IN FILLED CONDITION.
13. AIR RELIEF VALVE SHALL BE PROVIDED IN AIR WASHER PIPING.
14. FLOAT VALVE SHALL BE ADEQUATE TO FUNCTION FOR 10 KG/CM2 WATER PRESSURE.

REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD

JOB NO. 510
STATUS CONTRACT
DISTRIBUTION

PACKAGE	VENTILATION SYSTEM
PROJECT	1X800 MW ULTRA SUPER CRITICAL EXPANSION UNIT, DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR
OWNER	HARYANA POWER GENERATION CORPORATION LTD.
OWNER'S CONSULTANT	DESEIN PRIVATE LIMITED CONSULTING ENGINEERS, NEW DELHI
OWNER'S REVIEW CONSULTANT	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS, KOLKATA
EPC CONTRACTOR	BHARAT HEAVY ELECTRICALS LTD, NEW DELHI
BHEL UNIT	BHARAT HEAVY ELECTRICALS LTD, POWER SECTOR PROJECT ENGINEERING MANAGEMENT,NOIDA

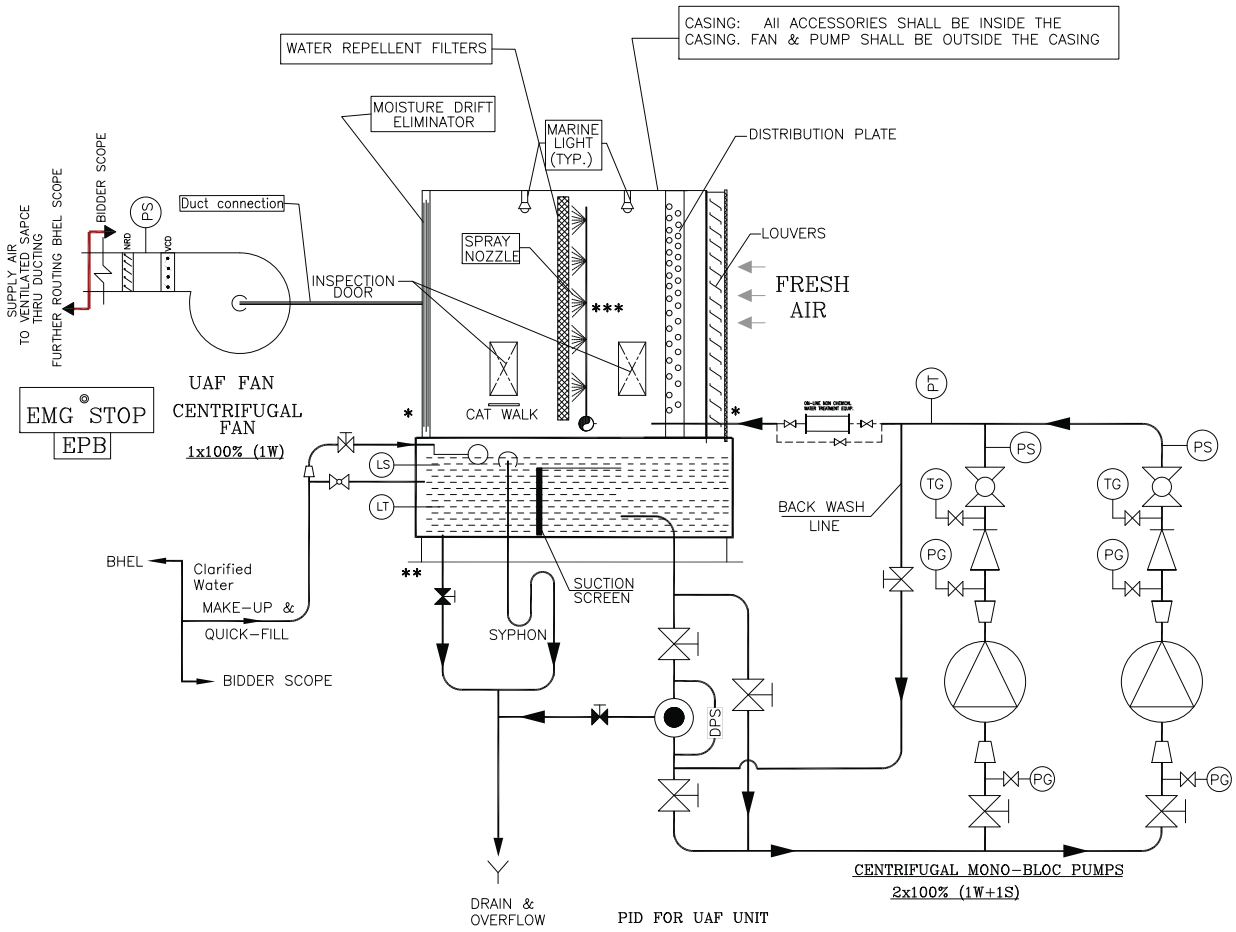
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The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED it must not be used directly or indirectly in any way detrimental to the interest of the company.

DEPT CODE		NAME	SIGN	DATE
A	DRN	DN		03.10.2025
	DESN	DN		03.10.2025
	CHD	AK		03.10.2025
	APPD	SR		03.10.2025

TITLE –
PID FOR AIRWASHER UNIT AND UAF UNIT FOR VENTILATION SYSTEM

DEPT. | SCALE 1:225 | SIGN | DRAWING NO. PE-DG-510-554-A001
SHEET 1 OF 2 | REV. 00
SIZE–A1

Page 546 of 563



PID FOR UAF UNIT

LEGEND: –

SYMBOL	DESCRIPTION	LOCATION
	GATE VALVE	AS PER PID
	GATE VALVE (NORMALLY CLOSED)	AS PER PID
	GLOBE VALVE	AS PER PID
	CHECK VALVE (NON-RETURN VALVE)	EACH PUMP OUTLET
	POT STRAINER	AT PUMP SUCTION HEADER
	VOLUME CONTROL DAMPER	FAN OUTLET
	CENTRIFUGAL PUMP	AS PER PID
	PRE FILTER	AS PER PID
PG	PRESSURE GAUGE	IN/OUT DISCHARGE OF PUMP.
PS	PRESSURE SWITCH	OUTLET OF PUMP & FAN
LS	LEVEL SWITCH (LLS & HLS)	UAF TANK
	FLOAT VALVE	UAF TANK
	REDUCER	AS PER PID
	SCOPE OF SUPPLY	AS PER PID
	CENTRIFUGAL FAN	AS PER PID
DPS	DIFFERENTIAL PRESSURE SWITCH	ACROSS POT STRAINER
TG	TEMPERATURE GAUGE	OUTLET OF PUMP
PT	PRESSURE TRANSMITTER	OUTLET HEADER OF PUMP
LT	LEVEL TRANSMITTER	UAF TANK

* The mist eliminator frame and the air distribution plate frame shall be located within the tank frame. This shall enable the water drooping down the respective frames directly into the tank, thereby avoiding leakages.

** Width of tank of UAF shall cover complete width of UAF so that there is no spillage of water and water falling from spray nozzles falls back into the tank. Necessary covering (using GI sheets) on UAF panels besides spray nozzles shall be provided to further stop spillage of water.

*** Uniform distribution of water through each spray nozzle shall be ensured in the UAF spray section. Difference in pressure in spray nozzles due to head difference shall be corrected by using different sizes of nozzles/pipe size adjustment suitably.

THIS P&ID IS INDICATIVE AND FOR TENDER PURPOSE ONLY

GENERAL NOTES:

1. SATURATION EFFICIENCY OF UAF SHALL BE 70% MINIMUM.
2. ALL PIPES FOR UAF SHALL HEAVY GRADE AS PER IS: 1239 PART-I UPTO 150NB, IS 3589 FOR PIPE ABOVE 150 NB AND FITTINGS SHALL BE AS PER IS: 1239 PART-II.
3. GI LOUVERS (FIXED BLADE TYPE) SHALL BE COMPLETE WITH GI BIRD SCREEN
4. ALL EQUIPMENTS DRAIN SHALL BE TERMINATED TO NEAREST FLOOR DRAIN.
5. IN THE UAF TANK LEVEL SWITCH SHALL BE PROVIDED FOR ALARM/ TRIP.
6. CAT WALK OF 450mm WIDE SHALL BE PROVIDED.
7. SIZE OF INSPECTION DOOR: 600mm x 700 mm (H)
8. FIRE DAMPERS (MOTORISED) SHALL BE PROVIDED OPEN/CLOSE LIMIT CONNECTED TO THE DCS IN THE SUPPLY DUCT TO MCC/SWITCHGEAR ROOM AND CABLE SPREADER ROOM.
9. EMERGENCY PUSH BUTTON (EPB) SHALL BE PROVIDED FOR CENTRIFUGAL FAN FOR EACH UAF UNIT FOR EMERGENCY STOP.
10. GI PIPES HEAVY CLASS FOR UAF SHALL BE PROVIDED FOR SPRAY SYSTEM.
11. ALL UAF CASING, TANK, FAN, COMPONENT ACCESSORIES SHALL HAVE SURFACE CORROSION PROTECTION PAINTING AS PER SPECIFICATION.
12. NECESSARY HEIGHT DIFFERENCE BETWEEN PUMP INLET AND MINIMUM WATER LEVEL IN TANK SHALL BE MAINTAINED SO THAT PUMP IS ALWAYS IN FILLED CONDITION.
13. AIR RELIEF VALVE SHALL BE PROVIDED IN UAF PIPING.
14. FLOAT VALVE SHALL BE ADEQUATE TO FUNCTION FOR 10 KG/CM2 WATER PRESSURE.

REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD
.	.													

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OWNER'S REVIEW CONSULTANT	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS, KOLKATA
EPC CONTRACTOR	BHARAT HEAVY ELECTRICALS LTD, NEW DELHI
BHEL UNIT	BHARAT HEAVY ELECTRICALS LTD, POWER SECTOR PROJECT ENGINEERING MANAGEMENT,NOIDA

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DEPT CODE		NAME	SIGN	DATE
A	DRN	DN		03.10.2025
	DESN	DN		03.10.2025
	CHD	AK		03.10.2025
	APPD	SR		03.10.2025

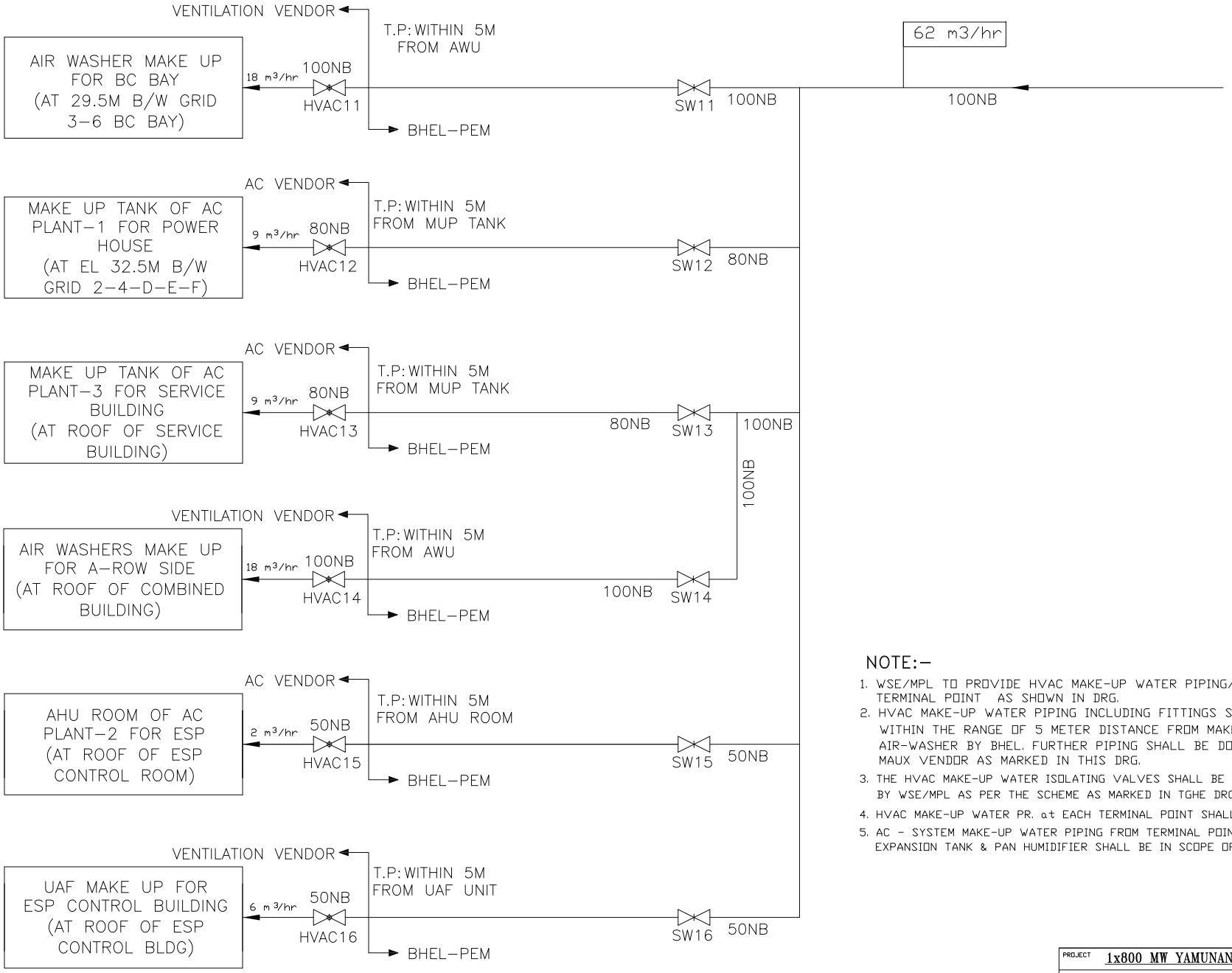
TITLE –
PID FOR AIRWASHER UNIT AND UAF UNIT FOR VENTILATION SYSTEM

DEPT. | SCALE 1:225 | DRAWING NO. PE-DG-510-554-A001
SIGN | SHEET 2 OF 2 | REV. 00

SIZE-A1

COMPUTER FILE NAME: 510-150-A008

MAKE UP WATER SCHEME FOR HVAC SYSTEM



NOTE:-

1. WSE/MPL TO PROVIDE HVAC MAKE-UP WATER PIPING/FITTINGS UP TO THE TERMINAL POINT AS SHOWN IN DRG.
2. HVAC MAKE-UP WATER PIPING INCLUDING FITTINGS SHALL BE TERMINATED WITHIN THE RANGE OF 5 METER DISTANCE FROM MAKE-UP WATER TANK / AIR-WASHER BY BHEL. FURTHER PIPING SHALL BE DONE BY RESPECTIVE MAUX VENDOR AS MARKED IN THIS DRG.
3. THE HVAC MAKE-UP WATER ISOLATING VALVES SHALL BE ARRANGED BY WSE/MPL AS PER THE SCHEME AS MARKED IN TGHE DRG.
4. HVAC MAKE-UP WATER PR. at EACH TERMINAL POINT SHALL BE MAINTAINED 0.5 kg/cm2.
5. AC - SYSTEM MAKE-UP WATER PIPING FROM TERMINAL POINT TO MAKE-UP WATER TANK, EXPANSION TANK & PAN HUMIDIFIER SHALL BE IN SCOPE OF MAUX AC SYSTEM VENDOR

PROJECT	1x800 MW YAMUNANAGAR (510)		
TITLE	MAKE UP WATER SCHEME FOR HVAC SYSTEM		
		DATE	CHECKED
SCALE	NTS	DRAWN	APPROVED

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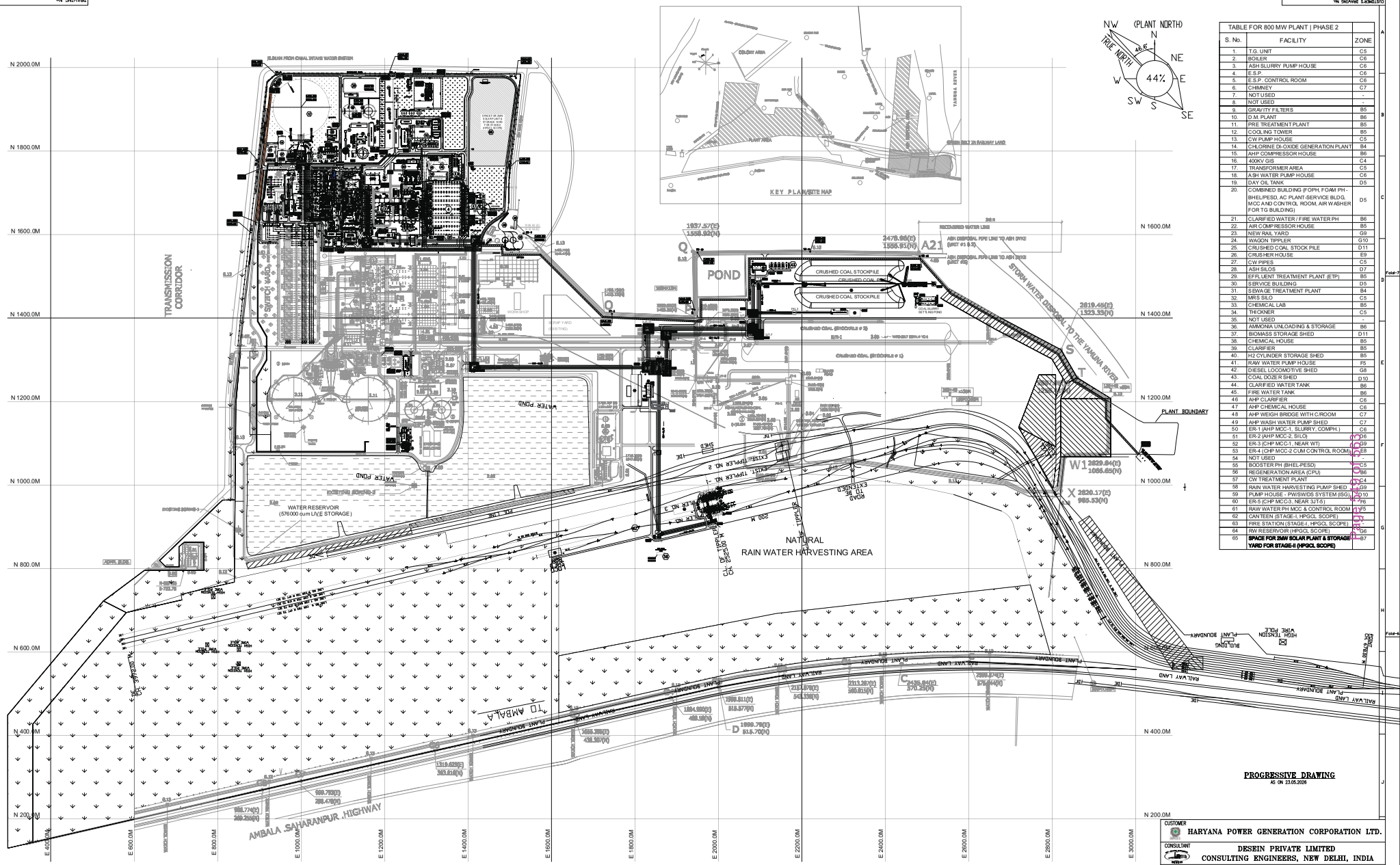


TABLE FOR 800 MW PLANT | PHASE 2		
S. No.	FACILITY	ZONE
1.	T.G. UNIT	C5
2.	BOILER	C6
3.	ASH SLURRY PUMP HOUSE	C6
4.	E.S.P.	C6
5.	E.S.P. CONTROL ROOM	C6
6.	CHIMNEY	C7
7.	NOT USED	-
8.	NOT USED	-
9.	GRAVITY FILTERS	B5
10.	D.M. PLANT	B6
11.	PRE TREATMENT PLANT	B5
12.	COOLING TOWER	B5
13.	CW PUMP HOUSE	C5
14.	CHLORINE DI-OXIDE GENERATION PLANT	B4
15.	AHP COMPRESSOR HOUSE	B6
16.	400KV GIS	C4
17.	TRANSFORMER AREA	C5
18.	ASH WATER PUMP HOUSE	C6
19.	DAY OIL TANK	D5
20.	COMBINED BUILDING (FOPH, FOAM PH - BHEL/PESD, AC PLANT-SERVICE BLDG, MCC AND CONTROL ROOM, AIR WASHER FOR TG BUILDING)	D5
21.	CLARIFIED WATER / FIRE WATER PH	B6
22.	AIR COMPRESSOR HOUSE	B5
23.	NEW RAIL YARD	G9
24.	WAGON TIPPLER	G10
25.	CRUSHED COAL STOCK PILE	D11
26.	CRUSHER HOUSE	E9
27.	CW PIPES	C5
28.	ASH SILOS	D7
29.	EFFLUENT TREATMENT PLANT (ETP)	B5
30.	SERVICE BUILDING	D5
31.	SEWAGE TREATMENT PLANT	B4
32.	MRS SILO	C5
33.	CHEMICAL LAB	B5
34.	THICKNER	C5
35.	NOT USED	-
36.	AMMONIA UNLOADING & STORAGE	B6
37.	BIOMASS STORAGE SHED	D11
38.	CHEMICAL HOUSE	B5
39.	CLARIFIER	B5
40.	H2 CYLINDER STORAGE SHED	B5
41.	RAW WATER PUMP HOUSE	F5
42.	DIESEL LOCOMOTIVE SHED	G8
43.	COAL DOZER SHED	D10
44.	CLARIFIED WATER TANK	B6
45.	FIRE WATER TANK	B6
46	AHP CLARIFIER	C6
47	AHP CHEMICAL HOUSE	C6
48	AHP WEIGH BRIDGE WITH C/ROOM	C7
49	AHP WASH WATER PUMP SHED	C7
50	ER-1 (AHP MCC-1, SLURRY, COMPH.)	C6
51	ER-2 (AHP MCC-2, SILO)	D6
52	ER-3 (CHP MCC-1, NEAR WT)	E9
53	ER-4 (CHP MCC-2 CUM CONTROL ROOM)	E8
54	NOT USED	-
55	BOOSTER PH (BHEL-PESD)	C5
56	REGENERATION AREA (CPU)	B6
57	CW TREATMENT PLANT	C4
58	RAIN WATER HARVESTING PUMP SHED	G9
59	PUMP HOUSE - PW/SW/DS SYSTEM (ISG)	D10
60	ER-5 (CHP MCC-3, NEAR SJ T/F)	F6
61	RAW WATER PH MCC & CONTROL ROOM	F5
62	CANTEEN (STAGE-I, HPGCL SCOPE)	-
63	FIRE STATION (STAGE-I, HPGCL SCOPE)	-
64	RW RESERVOIR (HPGCL SCOPE)	G6
65	**SPACE FOR 25MW SOLAR PLANT & STORAGE YARD FOR STAGE-II (HPGCL SCOPE)**	B7

PROGRESSIVE DRAWING
AS ON 23.05.2026

LEGEND:

1. PIPE CUM CABLE TRESTLE (BHEL–PEM)
2. CABLE TRESTLE (BHEL–PEM)
3. PIPE CUM CABLE TRESTLE (BHEL–ISG)
4. EXISTING ROAD

NOTES:–

1. ALL DIMENSIONS ARE IN MM & ELEVATIONS IN METERS UNLESS STATED OTHERWISE.
2. RL AT ALL LOCATIONS IN 800MW UNIT–III, STAGE–2 IS (+)270.0M, UNLESS OTHERWISE MARKED.
3. FINISH FLOOR LEVEL = RL (+)270.50M, WHICH CORRESPONDS TO EL 0.0M (GROUND FLOOR OF STG BUILDING).

REV.	DATE	ALTD	CHD	APPD
2	23.01.2026	RC	PM	BVA
1	DRAWING REVISED AS PER HPGCL COMMENTS ON RDV. 1.			
1	30.08.2024	RC	PM	BVA
	DRAWING REVISED AS PER HPGCL COMMENTS ON RDV. 0.			

JOB NO.	510
STATUS	CONTRACT
DISTRIBUTION	

CUSTOMER: HARYANA POWER GENERATION CORPORATION LTD.

CONSULTANT: DESEIN PRIVATE LIMITED
CONSULTING ENGINEERS, NEW DELHI, INDIA

1x800MW DEEN BANDHU CHOTU RAM
SUPER THERMAL POWER PLANT, YAMUNA NAGAR

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA

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DEPT	NAME	SIGN	DATE
CODE	BVA		08.05.2026
M	RC		08.05.2026
CHD	PM		08.05.2026
APPD	BVA		08.05.2026

TITLE: **PLOT PLAN**

DEPT. | SCALE 1:400 | DRAWING NO. PR-DG-510-100-M001
SIGN | SHEET 1 OF 1 | REV. 2

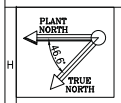
SIZE–A0

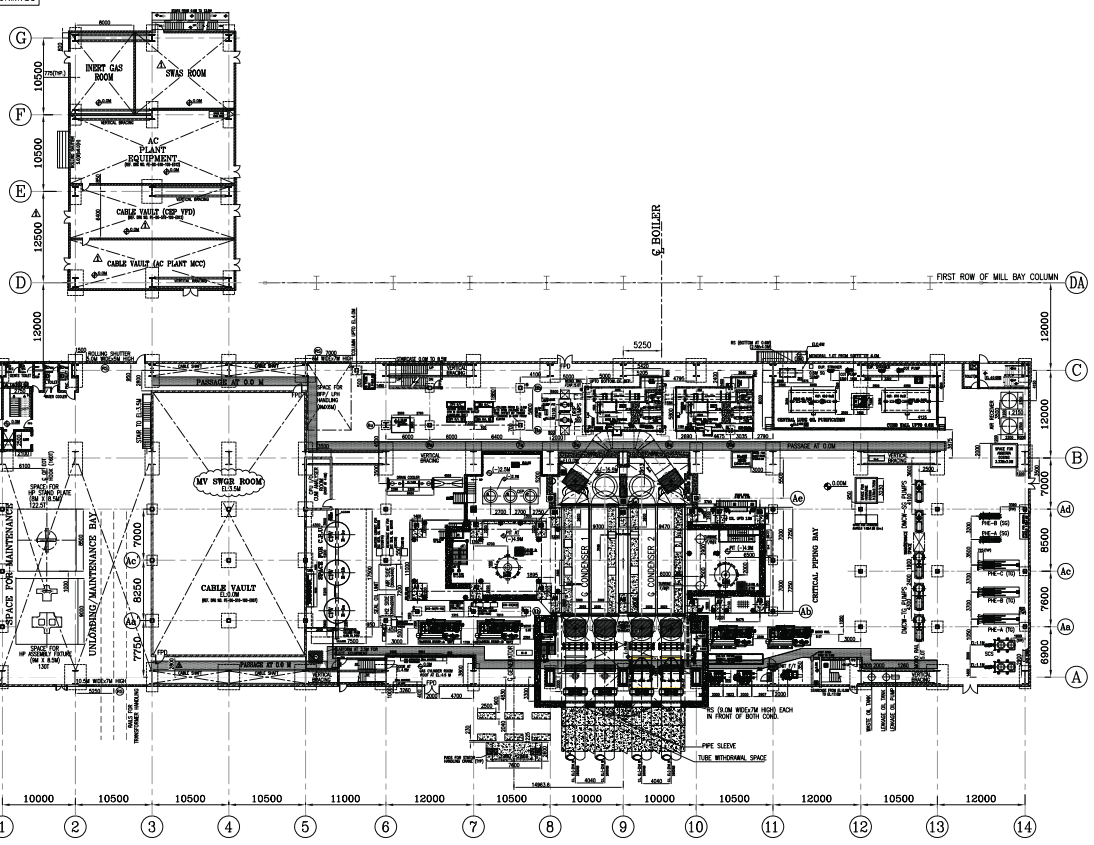
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FIRST ANGLE PROJECTION

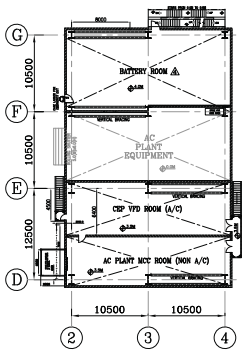
ALL DIMENSIONS ARE IN MM

DRAWING NO. PE-DG-510-100-M003

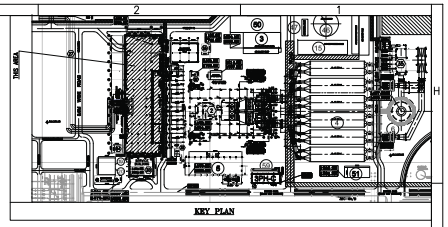




TG HALL EQUIPMENT LAYOUT PLAN AT EL: 0.0M



PLAN AT EL. 3.5M/4.0M
(CONTROL TOWER AREA)



KEY PLAN

⚠ ABBREVIATION LIST

SL NO.	ABBREVIATION	FULL FORM	SL NO.	ABBREVIATION	FULL FORM
1	EOT	ELECTRONIC OVERHEAD TRAVEL	21	LV SWGR	LOW VOLTAGE SWITCHGEAR
2	MS	MAIN STEAM	22	PW	POTABLE WATER
3	CRH	COLD REHEAT	23	CEP	CONDENSATE EXTRACTION PUMP
4	HRH	HOT REHEAT	24	CPU	CONDENSATE POLISHING UNIT
5	LPBP	LOW PRESSURE BYPASS	25	VFD	VARIABLE FREQUENCY DRIVE
6	HPBP	HIGH PRESSURE BYPASS	26	HPSU	HIGH PRESSURE OIL SUPPLY UNIT
7	CW	COOLING WATER	27	ESV	EMERGENCY STOP VALVE
8	HVAC	HEATING & VENTILATION AIR CONDITIONING	28	IV	INTERCEPTOR VALVE
9	MCC	MOTOR CONTROL	29	OLV	OVER LOAD VALVE
10	AHU	AIR HANDLING UNIT	30	F/T	FLASH TANK
11	FPD	FIRE PROOF DOOR	31	GSC	GLAND STEAM CONDENSOR
12	CR	CABLE RISER	32	DMWS	STEAM AND WATER ANALYSIS ROOM
13	PRDS	PRESSURE REDUCING DE-SUPER HEATING STATION	33	DDT	DIRTY OIL TANK
14	RS	ROLLING SHUTTER	34	CDT	CLEAN OIL TANK
15	BF	BOOSTER PUMP	35	EOP	EMERGENCY OIL PUMP
16	BFP	BOILER FEED PUMP	36	JOP	JACKING OIL PUMP
17	D/A	DEAERATOR	37	TOG	TOP OF GRATING
18	LPH	LOW PRESSURE HEATER	38	PHE	PLATE HEAT EXCHANGER
19	HPH	HIGH PRESSURE HEATER	39	SCS	SELF CLEAN STRAINER
20	VD	VENTILATION DUCT	40	DMCW	DE-MINERALISED COOLING WATER

LEGENDS

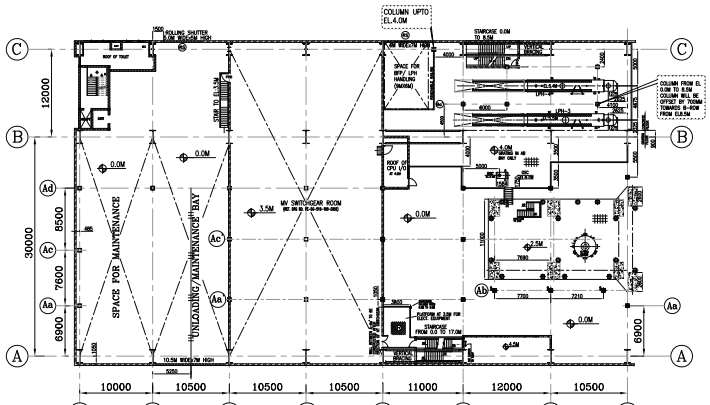
	PIPE HATCH
	VERTICAL BRACING
FPD	FIRE PROOF DOOR
	GRATING
	CHEQUERED PLATE
R	REMOVABLE
	HAND RAILING
	CABLE TRAY
	FIRE BARRIER WALL
	PIPE/CABLE TRESTLE
RS	ROLLING SHUTTER
	RAIL TRACK
	CABLE TRENCH
	PASSAGEWAY
	BRICK WALL

CIVIL TO NOTE:

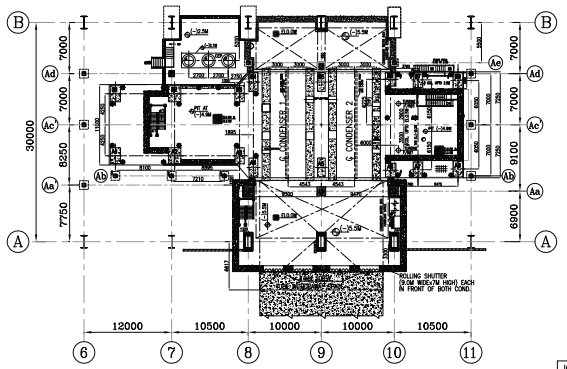
$ COLUMN FROM 0.0 TO -13.5(BOTTOM OF OIL CANAL)
COLUMN UPTO EL:2.5M
@ COLUMN UPTO BOTTOM OF BFP DECK
MAX BEAM DEPTH FOR PLATFORM BELOW TG DECK AT EL:2.5M TO BE RESTRICTED TO 400MM.

REFERENCE DRGS:

SL.No.	TITLE	NUMBER	UNIT
1	MAIN PLANT EQUIPMENT LAYOUT PLAN	PE-DG-510-100-M002	PEM
2	TG EQUIPMENT PLAN AT EL8.5 M	PE-DG-510-100-M004	PEM
3	TG EQUIPMENT PLAN AT EL17.0 M	PE-DG-510-100-M005	PEM
4	TG EQUIPMENT PLAN AT MISCELLANEOUS FLOORS IN BC BAY	PE-DG-510-100-M006	PEM
5	T.G. HALL CROSS SECTION	PE-DG-510-100-M007	PEM
6	CONDENSER ASSEMBLY (GENERAL ARRANGEMENT)	0180107007124I	HWI
7	GENERAL ARRANGEMENT OF DRAIN COOLER	---	HYD
8	GENERAL ARRANGEMENT OF GLAND STEAM CONDENSER	---	HWI
9	GENERAL ARRANGEMENT OF LPH # 3	---	HYD
10	GENERAL ARRANGEMENT OF LPH # 4	---	HYD
11	GENERAL ARRANGEMENT F / T-A	---	BPL
12	GENERAL ARRANGEMENT F / T-B	---	BPL
13	GENERAL ARRANGEMENT OF CEP	---	HYD
14	GENERAL ARRANGEMENT OF VACCUM PUMPS CONDENSER # 1	---	HWI
15	GENERAL ARRANGEMENT OF VACCUM PUMPS CONDENSER # 2	---	HWI
16	EQUIPMENT LAYOUT FOR TDBFP	---	HYD
17	GA & FOUNDATION DETAILS DRP PUMPS	---	HYD
18	GA WASTE OIL TANK	---	HWI
19	GA OF PHE	---	PEM
20	GA DMCW PUMP	---	PEM
21	GA LEAKAGE/DIRTY TANK AND PUMP	---	HWI
22	AIR RECEIVER	---	BPL
23	GA OF CPU (EQUIPMENT LAYOUT FOR SERVICE VESSEL AREA)	---	PEM
24	GA AMMONIA SKID	---	PEM
25	GA HYDRAZINE SKID	---	PEM
26	GA OF OXYGEN DOSING	---	PEM
27	GA NAOH TANK / SKID	---	PEM
28	LIST OF JUNCTION BOX	---	HWI
29	GA OF COLTCS	---	PEM
30	EPs AND FLOOR OPENINGS IN TG BUILDING	PE-DG-510-100-M019	PEM
31	DIMENSIONAL SKETCH FOR MOUNTING FRAMS & HP PLATE	DSPPG-004828	HWI
32	GA OF MV SWITCHGEAR ROOM	PE-DG-510-100-E002	PEM
33	CABLE TRAY LAYOUT BELOW MV SWITCHGEAR ROOM	PE-DG-510-100-E007	PEM



PLAN AT EL. 3.5/4.0M (AB & BC BAY)



PLATFORM AT 0.0M

NOTES:-

1. ALL DIMENSION ARE IN MM AND LEVELS ARE IN METRES.
2. ALL ELEVATION MARKED ARE W.R.T. TG HALL FINISHED FLOOR ELEVATION OF EL 0.00M WHICH CORRESPONDS TO RL(+)270.5M.
3. CABLE DUCT/TRENCH/SLIT LAYOUT IS SHOWN FOR REPRESENTATION PURPOSE ONLY. FOR DETAILS REFER ELECTRICAL DRAWING.
4. ELEVATIONS OF EQUIPMENT/PIPES INDICATED ARE CENTER LINE ELEVATIONS UNLESS OTHERWISE SPECIFIED.
5. FOR EXACT LOCATION AND DETAILS OF DOORS, WINDOWS, ROLLING SHUTTERS ETC., RELEVANT APPROVED ARCHITECTURAL DRGS. TO BE REFERRED.
6. FOR DETAILED ARRANGEMENT OF STAIRCASES, RESPECTIVE DETAILED DRAWINGS TO BE REFERRED.

REV.	DATE	ALTD	CHD	APPD
3	27.12.2024	VKS Sd/-	RC Sd/-	PM Sd/-
1	DRAWING REVISED AS PER MoM HELD DURING THE MEETING DTD. 10.12.2021 AND 11.12.2024. REVISION MARKED AS ⚠			

REV.	DATE	ALTD	CHD	APPD
2	14.10.2024	VKS Sd/-	RC Sd/-	PM Sd/-
1	DRAWING BEING RESUBMITTED.			

REV.	DATE	ALTD	CHD	APPD
1	05.08.2024	VKS Sd/-	RC Sd/-	PM Sd/-
1	DRAWING REVISED AS PER HPGCL COMMENTS ON REV-0 DTD. 2.07.2024. REVISION MARKED AS ⚠			

JOB NO. 510
STATUS CONTRACT
DISTRIBUTION

PROJECT: 1X800 MW ULTRA SUPER CRITICAL EXPANSION UNIT, DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR

OWNER: HARYANA POWER GENERATION CORPORATION LTD.

OWNER'S CONSULTANT: DESEIN PRIVATE LIMITED, CONSULTING ENGINEERS, NEW DELHI

OWNER'S REVIEW CONSULTANT: DEVELOPMENT CONSULTANTS PVT. LTD., CONSULTING ENGINEERS, KOLKATA

EPC CONTRACTOR: BHARAT HEAVY ELECTRICALS LTD, NEW DELHI

BHEL UNIT: BHARAT HEAVY ELECTRICALS LTD, POWER SECTOR PROJECT ENGINEERING MANAGEMENT,NOIDA

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DEPT CODE	NAME	SIGN	DATE
MPL	DRN VKS		20.06.2024
	DESN RC		20.06.2024
	CHD RC		20.06.2024
	APPD BKA		20.06.2024

TITLE:- TG EQUIPMENT PLAN AT GROUND FLOOR (AT EL 0.0M)

DEPT. | SCALE 1:225 | SIGN | DRAWING NO. PE-DG-510-100-M003

SHEET 1 OF 1 | REV. 3

SIZE-A0

COMPUTER FILE NAME: 510-100-M003

Fold-1 Fold-2 Fold-3 Fold-4

FIRST ANGLE PROJECTION

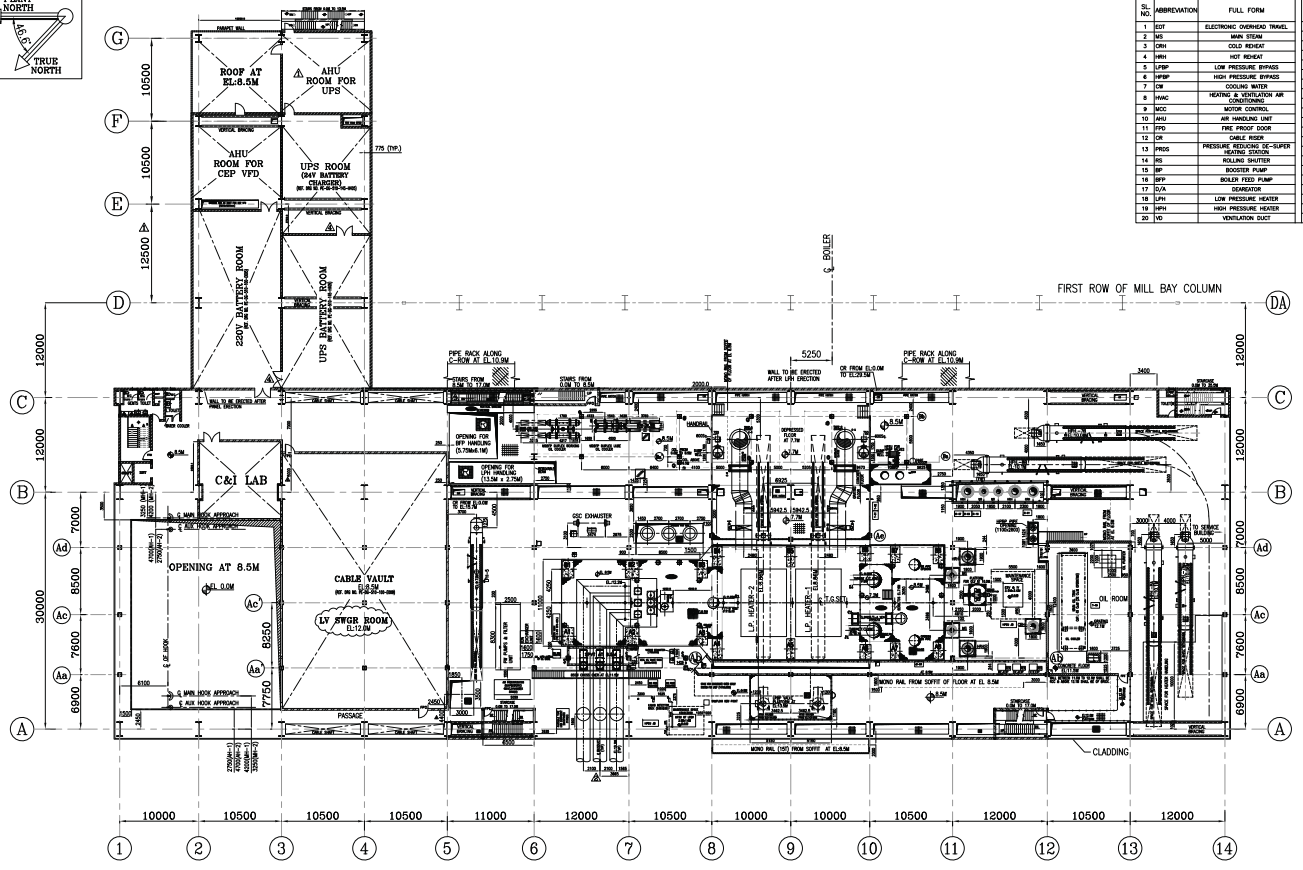
ALL DIMENSIONS ARE IN MM

DRAWING NO. PE-DG-510-100-M004

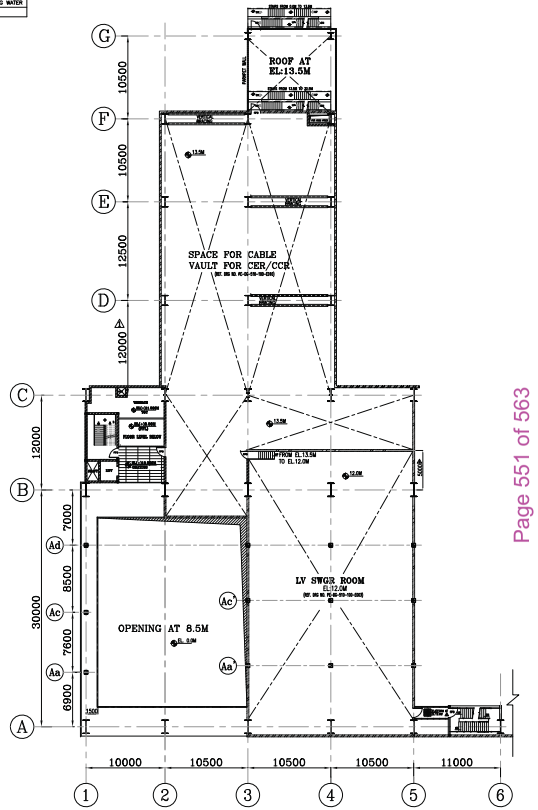
PLANT NORTH

45.5°

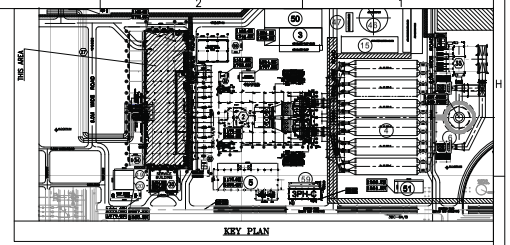
TRUE NORTH



PLAN AT EL:7.7/8.5M



PLAN AT EL:12.0M/13.5M



ABBREVIATION LIST

SL. NO.	ABBREVIATION	FULL FORM	SL. NO.	ABBREVIATION	FULL FORM
1	EOT	ELECTRONIC OVERHEAD TRAVEL	21	LV SWGR	LOW VOLTAGE SWITCHGEAR
2	MS	MAIN STEAM	22	PW	POTABLE WATER
3	CRH	COLD REHEAT	23	CEP	CONDENSATE EXTRACTION PUMP
4	HRH	HOT REHEAT	24	CPU	CONDENSATE POLISHING UNIT
5	LPBP	LOW PRESSURE BYPASS	25	VFD	VARIABLE FREQUENCY DRIVE
6	HPBP	HIGH PRESSURE BYPASS	26	HPSU	HIGH PRESSURE OIL SUPPLY UNIT
7	CW	COOLING WATER	27	ESV	EMERGENCY STOP VALVE
8	HVAC	HEATING & VENTILATION AIR CONDITIONING	28	IV	INTERCEPTOR VALVE
9	MCC	MOTOR CONTROL	29	OLV	OVER LOAD VALVE
10	AHU	AIR HANDLING UNIT	30	F/T	FLASH TANK
11	FPD	FIRE PROOF DOOR	31	GSC	GLAND STEAM CONDENSOR
12	CR	CABLE RISER	32	SWAS	STEAM AND WATER ANALYSIS ROOM
13	PRDS	PRESSURE REDUCING DE-SUPER HEATING STATION	33	DOT	DIRTY OIL TANK
14	RS	ROLLING SHUTTER	34	COT	CLEAN OIL TANK
15	BP	BOOSTER PUMP	35	EOP	EMERGENCY OIL PUMP
16	BFP	BOILER FEED PUMP	36	JOP	JACKING OIL PUMP
17	D/A	DEAERATOR	37	TOG	TOP OF GRATING
18	LPH	LOW PRESSURE HEATER	38	PHE	PLATE HEAT EXCHANGER
19	HPH	HIGH PRESSURE HEATER	39	SCS	SELF CLEAN STRAINER
20	VD	VENTILATION DUCT	40	DMCW	DE-MINERALISED COOLING WATER

REFERENCE DRGS:

SL NO	TITLE	NUMBER	UNIT
1	TG EQUIPMENT PLAN AT EL 0.0 M	PE-DG-510-100-M003	PEM
2	TG EQUIPMENT PLAN AT EL17.0 M	PE-DG-510-100-M005	PEM
3	TG EQUIPMENT PLAN AT MISCELLANEOUS FLOORS IN BC BAY	PE-DG-510-100-M006	PEM
4	T.G. HALL CROSS SECTION	PE-DG-510-100-M007	PEM
5	OIL ROOM ARRANGEMENT	---	HWR
6	LP BYPASS VALVE ARRANGEMENT	---	HWR
7	OIL CANAL DETAILS	---	HWR
8	GA OF LP HEATER 1	---	HWR
9	GA OF LP HEATER 2	---	HWR
10	GA OF LP HEATER 5	---	HYD
11	GA HP HEATER 7A	---	HYD
12	GA HP HEATER 7B	---	HYD
13	GA HP HEATER 8A	---	HYD
14	GA HP HEATER 8B	---	HYD
15	HPSU FOR ESV, IV & OVER LOAD VALVE	---	HWR
16	HPSU FOR LP BYPASS VALVE	---	HWR
17	GA OF MDBFP HC COOLERS	---	HYD
18	GA OF OLV	---	HWR/SAG
19	GA OF HP BP VALVE	---	TRY
20	TURBINE JB LIST & LAYOUT	---	HWR
21	ASSEMBLY PLATFORM FOR OVERLOAD VALVE	---	HWR
22	TDBFP LUBE OIL EQUIPMENT LAYOUT	---	HYD
23	SWAS ROOM LAYOUT	---	PEM
24	TURBINE & GEN JUNCTION BOXES LISTS & LAYOUT	---	HWR
25	LAYOUT OF DC EQUIPMENT ROOM	---	PEM
26	GA OF LV SWITCHGEAR ROOM	PE-DG-510-100-E003	PEM
27	CABLE TRAY LAYOUT BELOW LV SWITCHGEAR ROOM	PE-DG-510-100-E008	PEM
28	UPS BATTERY ROOM	PE-DG-510-145-H405	PEM
29	OIL ROOM ARRANGEMENT DRAWING	0-13100-J5010	HWR
30	GA OF OIL MODULE	---	HWR

LEGENDS

	PIPE HATCH
	VERTICAL BRACING
FPD	FIRE PROOF DOOR
	GRATING
	CHEQUERED PLATE
(R)	REMOVABLE
	HAND RAILING
	CABLE TRAY
	FIRE BARRIER WALL
	PIPES/CABLE TRESTLE.
(RS)	ROLLING SHUTTER
	RAIL TRACK
PTC	PIPE TRENCH WITH RCC COVERED SAND FILLED
	BRICK WALL
	BUS DUCT
	WALK WAY
	CONCRETE

NOTES:-

1. ALL DIMENSION ARE IN MM AND LEVELS ARE IN METRES.
2. ALL ELEVATION MARKED ARE W.R.T. TG HALL FINISHED FLOOR ELEVATION OF EL 0.00M WHICH CORRESPONDS TO RL(+)270.5M.
3. CABLE DUCT/TRENCH/SLIT LAYOUT IS SHOWN FOR REPRESENTATION PURPOSE ONLY. FOR DETAILS REFER ELECTRICAL DRAWING.
4. ELEVATIONS OF EQUIPMENT/PIPES INDICATED ARE CENTER LINE ELEVATIONS UNLESS OTHERWISE SPECIFIED.
5. FOR EXACT LOCATION AND DETAILS OF DOORS, WINDOWS, ROLLING SHUTTERS ETC., RELEVANT APPROVED ARCHITECTURAL DRGS. TO BE REFERRED.

CIVIL TO NOTE:

$ COLUMN FROM 0.0 TO ~13.5(BOTTOM OF OIL CANAL)
@ COLUMN UPTO BOTTOM OF BFP DECK
SC* COLUMN FROM 8.5M TO 17.0M

REV.	DATE	ALTD	CHD	APPD
3	27.12.2024	VKS Sd/-	RC Sd/-	PM Sd/-
1	DRAWING REVISED AS PER MoM HELD DURING THE MEETING DTD. 10.12.2021 AND 11.12.2024.			
	REVISION MARKED AS ⚠			

REV.	DATE	ALTD	CHD	APPD
2	14.10.2024	VKS Sd/-	RC Sd/-	PM Sd/-
1	BUS DUCT ARRANGEMENT REVISED.			
	REVISION MARKED AS ⚠			

REV.	DATE	ALTD	CHD	APPD
1	05.08.2024	VKS Sd/-	RC Sd/-	PM Sd/-
1	DRAWING REVISED AS PER HPGCL COMMENTS ON REV-0 DTD. 2.07.2024.			
	REVISION MARKED AS ⚠			

JOB NO. 510

STATUS CONTRACT

DISTRIBUTION

PROJECT: 1X800 MW ULTRA SUPER CRITICAL EXPANSION UNIT, DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR

OWNER: HARYANA POWER GENERATION CORPORATION LTD.

OWNER'S CONSULTANT: DESEIN PRIVATE LIMITED, CONSULTING ENGINEERS, NEW DELHI

OWNER'S REVIEW CONSULTANT: DEVELOPMENT CONSULTANTS PVT. LTD., CONSULTING ENGINEERS, KOLKATA

EPC CONTRACTOR: BHARAT HEAVY ELECTRICALS LTD, NEW DELHI

BHEL UNIT: BHARAT HEAVY ELECTRICALS LTD, POWER SECTOR, PROJECT ENGINEERING MANAGEMENT,NOIDA

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DEPT CODE	NAME	SIGN	DATE
MPL DRN	VKS		20.06.2024
MPL DESN	RC		20.06.2024
MPL CHD	RC		20.06.2024
MPL APPD	BKA		20.06.2024

TITLE:-

TG EQUIPMENT PLAN AT MEZZANINE FLOOR (AT EL 8.5M)

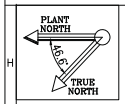
DEPT. | SCALE 1:225 | DRAWING NO. PE-DG-510-100-M004

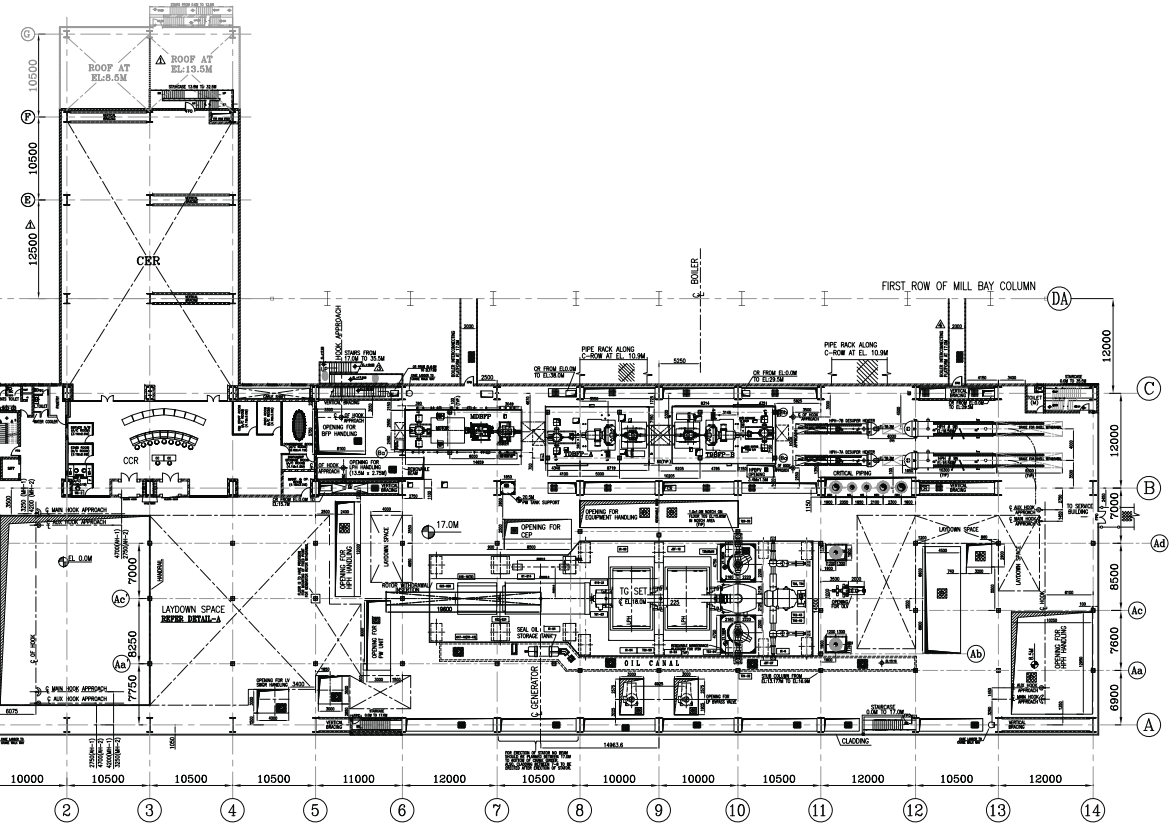
SIGN | SHEET 1 OF 1 | REV. 3

SIZE-A0

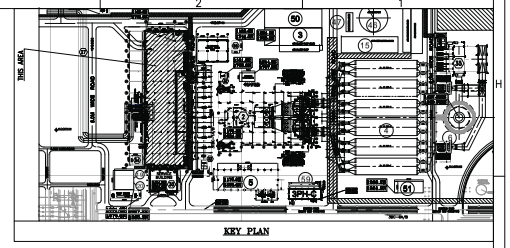
COMPUTER FILE NAME: 510-100-M004

Page 551 of 563





PLAN AT 17.0M



⚠ ABBREVIATION LIST

SL NO.	ABBREVIATION	FULL FORM	SL NO.	ABBREVIATION	FULL FORM
1	EOT	ELECTRONIC OVERHEAD TRAVEL	21	LV SWGR	LOW VOLTAGE SWITCHGEAR
2	MS	MAIN STEAM	22	PW	POTABLE WATER
3	CRH	COLD REHEAT	23	CEP	CONDENSATE EXTRACTION PUMP
4	HRH	HOT REHEAT	24	CPU	CONDENSATE POLISHING UNIT
5	LPBP	LOW PRESSURE BYPASS	25	VFD	VARIABLE FREQUENCY DRIVE
6	HPBP	HIGH PRESSURE BYPASS	26	HPSU	HIGH PRESSURE OIL SUPPLY UNIT
7	CW	COOLING WATER	27	ESV	EMERGENCY STOP VALVE
8	HVAC	HEATING & VENTILATION AIR CONDITIONING	28	IV	INTERCEPTOR VALVE
9	MCC	MOTOR CONTROL	29	OLV	OVER LOAD VALVE
10	AHU	AIR HANDLING UNIT	30	F/T	FLUSH TANK
11	FPD	FIRE PROOF DOOR	31	GSC	GLAND STEAM CONDENSOR
12	CR	CABLE RISER	32	DMAS	STEAM AND WATER ANALYSIS ROOM
13	PRDS	PRESSURE REDUCING DE-SUPER HEATING STATION	33	DOT	DIRTY OIL TANK
14	RS	ROLLING SHUTTER	34	COT	CLEAN OIL TANK
15	BP	BOOSTER PUMP	35	ECP	EMERGENCY OIL PUMP
16	BFP	BOILER FEED PUMP	36	JOP	JACKING OIL PUMP
17	D/A	DEAERATOR	37	TOG	TOP OF GRATING
18	LPH	LOW PRESSURE HEATER	38	PHE	PLATE HEAT EXCHANGER
19	HPH	HIGH PRESSURE HEATER	39	SCS	SELF CLEAN STRAINER
20	VD	VENTILATION DUCT	40	DMCW	DE-MINERALISED COOLING WATER

LEGENDS

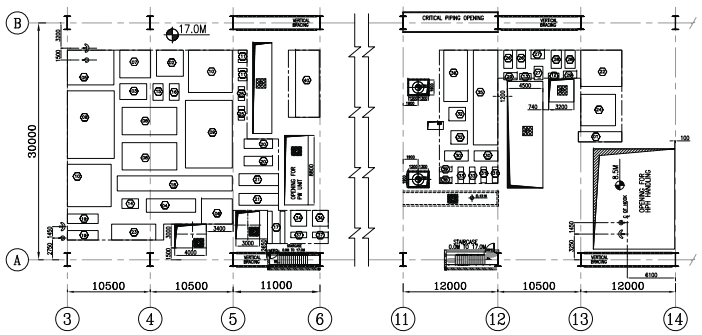
	PIPE HATCH
	VERTICAL BRACING
FPD	FIRE PROOF DOOR
	GRATING
	CHEQUERED PLATE
(R)	REMOVABLE
	HAND RAILING
	CABLE TRAY
	FIRE BARRIER WALL
	PIPES/CABLE TRESTLE.
(RS)	ROLLING SHUTTER
	RAIL TRACK
	PIPE TRENCH WITH PCC COVERED SAND FILLED
	BRICK WALL
	BUS DUCT
	WALK WAY
	CONCRETE

REFERENCE DRGS:

SL.NO.	TITLE	NUMBER	UNIT
1	TG EQUIPMENT PLAN AT EL 0.0 M	PE-DG-510-100-M003	PEM
2	TG EQUIPMENT PLAN AT EL 8.5 M	PE-DG-510-100-M004	PEM
3	TG EQUIPMENT PLAN AT MISCELLANEOUS FLOORS IN BC BAY	PE-DG-510-100-M006	PEM
4	T.G. CROSS SECTION	PE-DG-510-100-M007	PEM
5	GA OF MDBFP	---	HYD
6	GA OF TDBFP	---	HYD
7	GA OF HP HEATER 9A	---	HYD
8	GA OF HP HEATER 9B	---	HYD
9	GA OF DESUPERHEATER-7A	---	HYD
10	GA OF DESUPERHEATER-7B	---	HYD
11	FOUNDATION ARRANGEMENT FOR BFP AND DRIVE TURBINE	---	HYD
12	FOUNDATION ARRANGEMENT OF MDBFP	---	HYD
13	TG DECK FOUNDATION PLAN	---	HWR
14	OIL CANAL DETAILS	---	HWR
15	LAYDOWN SPACE FOR GENERATOR COMPONENTS	---	HWR
16	LAYDOWN SPACE FOR STEAM TURBINE COMPONENTS	---	HWR
17	REMOVABLE MAINTENANCE PLATFORM FOR IPSV	---	HWR

NOTES:–

1. ALL DIMENSION ARE IN MM AND LEVELS ARE IN METRES.
2. ALL ELEVATION MARKED ARE W.R.T. TG HALL FINISHED FLOOR ELEVATION OF EL 0.00M WHICH CORRESPONDS TO RL(+)270.5M.
3. CABLE DUCT/TRENCH/SLIT LAYOUT IS SHOWN FOR REPRESENTATION PURPOSE ONLY. FOR DETAILS REFER ELECTRICAL DRAWING.
4. ELEVATIONS OF EQUIPMENT/PIPES INDICATED ARE CENTER LINE ELEVATIONS UNLESS OTHERWISE SPECIFIED.
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DETAIL–A

EQUIPMENT LAYDOWN ARRANGEMENT FOR TG & GENERATOR COMPONENTS AT 17.0M

DETAIL OF LAY-DOWN SPACE FOR TG COMPONENTS

S.No	DESCRIPTION	WT.IN T	AREA M x M	S.No	DESCRIPTION	WT.IN T	AREA M x M
(A)	HP SHAFT	28.0	8.5 X 1.3	(K)	HYDROGEN COOLER (2 NOs 180t TYPE)	4.5	5.0 X 1.5
(B)	EXHAUST CASING	25.0	3.4 X 3.3	(L)	HYDROGEN COOLERS HOUSING	26.0	4.6 X 3.2
(C)	INNER CASING UPPER PART	17.0	3.4 X3.0	(M)	EXCITER	33.0	5.6 X 2.01
(D)	IP SHAFT	40.0	8.232 X 1.7	(N)	EXCITER HOUSING	2.5	4.4 X 2.87
(E)	IP TURBINE OUTER CASING UPPER PART	61.0	5.89 X 4.4	(O)	BEARING SHELLS -TG & EX 4NOS	0.9	0.5 X 0.8
(F)	IP TURBINE INNER CASING UPPER PART	32.0	3.9 X 3.2	(P)	HP CONTROL VALVE 2 Nos.	3.0	2.3 X 1.1
(G)	IP TURBINE INNER CASING LOWER PART	31.0	3.9 X 3.0	(Q)	HP CONTROL VALVE ACTUATOR 2 Nos.	2.0	1.7 X 1.1
(H)	LP1 & LP2 SHAFT	79.0	6.802 X 3.46	(R)	HP STOP VALVE 2 Nos.	4.5	2.6 X 1.3
(I)	LP1 & LP2 OUTER CASING UPPER PART	28.0	8.56 X 5.905	(S)	HP STOP VALVE ACTUATOR 2 Nos.	1.5	1.7 X 0.9
(J)	LP1 & LP2-INNER CASING UPPER HALF	26.0	8.56 X 5.36	(T)	IP CONTROL VALVE 2 Nos.	6.5	3.0 X 1.3
(T)	LP SHAFT SEAL CAS -TE & GE (4 Nos.)	0.5	0.405 X 1.12	(U)	IP CONTROL VALVE ACTUATOR 2 Nos.	1.8	2.0 X 0.7
(U)	HP FRONT BEARING UPPER PART PEDESTAL COVER	0.8	0.65 X 1.35	(V)	IP STOP VALVE 2 Nos.	7.0	3.1 X 1.7
(V)	HP REAR BEARING UPPER PART PEDESTAL COVER	0.9	0.8 X 1.45	(W)	IP STOP VALVE ACTUATOR 2 Nos.	1.4	2.1 X 0.7
(W)	IP REAR BEARING UPPER PART PEDESTAL COVER	2.3	1.215 X 2.1	(X)	LP BYPASS CONTROL VALVE 2 NOS	2.2	2.0 X 2.0
(X)	LP REAR BEARING UPPER PART PEDESTAL COVER	2.3	1.215 X 2.1	(Y)	CROSS OVER PIPE – PART1	20	12 X 2.1
(Y)	LP REAR-2 BEARING UPPER PART PEDESTAL COVER	2.3	1.215 X 2.1	(Z)	CROSS OVER PIPE – PART2	22	6.5 X 3
(Z)	GUIDE BLOCK CARRIER ASSEMBLY 2 NOS	3.85	4.1 X 0.8	(AA)	LP BYPASS CONTROL VALVE ACTUATOR 2 NOS	0.5	2 X 0.7
(AA)	GENERATOR – ROTOR	82.0	14.27 X 1.81	(AB)	OVERLOAD CONTROL VALVE	0.8	1.8 X 0.6
(AB)	END SHIELD UPPER & LOWER HALF (ES) 2 NOS	8.0	1.2 X 3.8	(AC)	OVERLOAD CONTROL VALVE ACTUATOR	1.0	1.8 X 0.6
(AC)	END SHIELD UPPER & LOWER HALF (TG) 2 NOS	8.0	1.2 X 3.8	(AD)	LIFTING BEAM	8.0	8.5 X 3.0

REV.	DATE	ALTD	CHD	APPD
3	27.12.2024	VKS Sd/–	RC Sd/–	PM Sd/–
1	DRAWING REVISED AS PER MoM HELD DURING THE MEETING DTD. 10.12.2021 AND 11.12.2024. REVISION MARKED AS ⚠			

REV.	DATE	ALTD	CHD	APPD
2	14.10.2024	VKS Sd/–	RC Sd/–	PM Sd/–
1	DRAWING BEING RESUBMITTED.			

REV.	DATE	ALTD	CHD	APPD
1	05.08.2024	VKS Sd/–	RC Sd/–	PM Sd/–
1	DRAWING REVISED AS PER HPGCL COMMENTS ON REV–0 DTD. 2.07.2024. REVISION MARKED AS ⚠			

JOB NO. 510
STATUS CONTRACT
DISTRIBUTION

PROJECT: 1X800 MW ULTRA SUPER CRITICAL EXPANSION UNIT, DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR
OWNER: HARYANA POWER GENERATION CORPORATION LTD.
OWNER'S CONSULTANT: DESEIN PRIVATE LIMITED CONSULTING ENGINEERS, NEW DELHI
OWNER'S REVIEW CONSULTANT: DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS, KOLKATA
EPC CONTRACTOR: BHARAT HEAVY ELECTRICALS LTD, NEW DELHI
BHEL UNIT: BHARAT HEAVY ELECTRICALS LTD, POWER SECTOR PROJECT ENGINEERING MANAGEMENT,NOIDA

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DEPT CODE		NAME	SIGN	DATE
MPL	DRN	VKS		20.06.2024
	DESN	RC		20.06.2024
	CHD	RC		20.06.2024
	APPD	BKA		20.06.2024

TITLE –
TG EQUIPMENT PLAN AT OPERATING FLOOR (AT EL 17.0M)

DEPT. | SCALE 1:225 | SIGN | DRAWING NO. PE-DG-510-100-M005 | SHEET 1 OF 1 | REV. 3

SIZE–A0

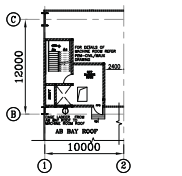
COMPUTER FILE NAME: 510-100-M005

FIRST ANGLE PROJECTION

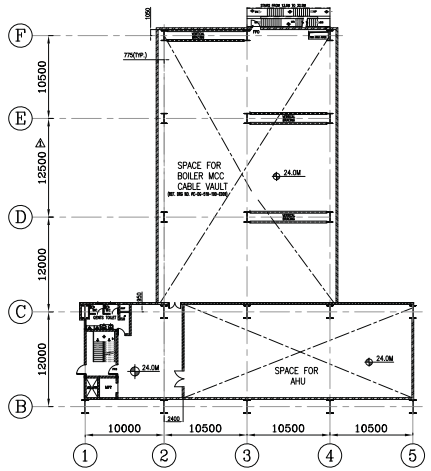
ALL DIMENSIONS ARE IN MM

DRAWING NO. PE-DG-510-100-M006

PLANT NORTH 15° TRUE NORTH



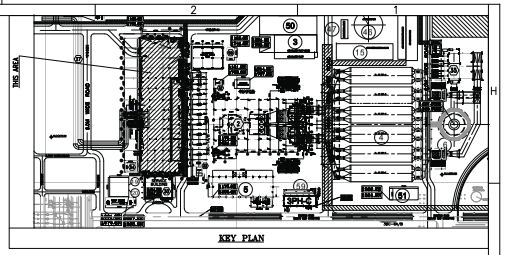
MACHINE ROOM PLAN AT EL(+)41.0M

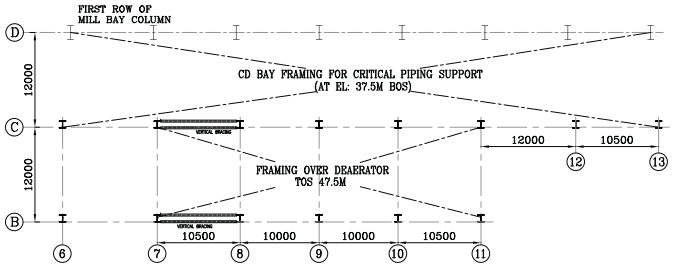


PLAN AT 24.0M

REFERENCE DRAWINGS:

SL No		DRG. NUMBER	UNIT
1	TG EQUIPMENT PLAN AT EL 0.0 M	PE-DG-510-100-M003	PEM
2	TG EQUIPMENT PLAN AT EL 8.5 M	PE-DG-510-100-M004	PEM
3	TG EQUIPMENT PLAN AT 17.0 M	PE-DG-510-100-M005	PEM
4	T.G. HALL CROSS SECTION	PE-DG-510-100-M007	PEM
5	GA OF SPRAY CUM TRAY DEAERATOR	--	HYD
6	GA D/A PLATFORM	--	HYD
7	GA OF DMCW TANK	--	BPL
8	GA OF POTABLE WATER TANK	--	BPL
9	GA AIR WASHER LAYOUT	--	PEM
10	GA OF SERVICE WATER TANK	--	BPL

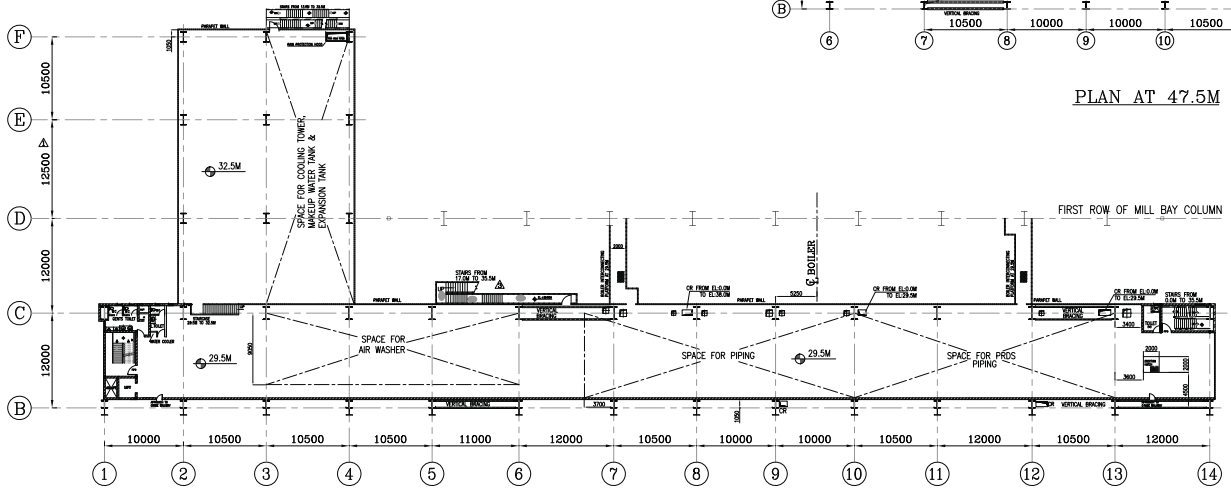




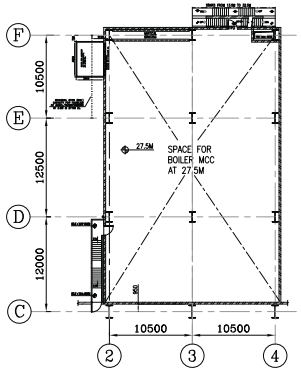
PLAN AT 47.5M

ABBREVIATION LIST

SL. NO.	ABBREVIATION	FULL FORM	SL. NO.	ABBREVIATION	FULL FORM
1	EOT	ELECTRONIC OVERHEAD TRAVEL	21	LV SWGR	LOW VOLTAGE SWITCHGEAR
2	MS	MAIN STEAM	22	PW	POTABLE WATER
3	CRH	COLD REHEAT	23	CEP	CONDENSATE EXTRACTION PUMP
4	HRH	HOT REHEAT	24	CPU	CONDENSATE POLISHING UNIT
5	LPBP	LOW PRESSURE BYPASS	25	VFD	VARIABLE FREQUENCY DRIVE
6	HPBP	HIGH PRESSURE BYPASS	26	HPSU	HIGH PRESSURE OIL SUPPLY UNIT
7	CW	COOLING WATER	27	ESV	EMERGENCY STOP VALVE
8	HVAC	HEATING & VENTILATION AIR CONDITIONING	28	IV	INTERCEPTOR VALVE
9	MCC	MOTOR CONTROL	29	OLV	OVER LOAD VALVE
10	AHU	AIR HANDLING UNIT	30	F/T	FLASH TANK
11	FPD	FIRE PROOF DOOR	31	GSC	GLAND STEAM CONDENSOR
12	CR	CABLE RISER	32	SWAS	STEAM AND WATER ANALYSIS ROOM
13	PRDS	PRESSURE REDUCING DE-SUPER HEATING STATION	33	DOT	DIRTY OIL TANK
14	RS	ROLLING SHUTTER	34	COT	CLEAN OIL TANK
15	BP	BOOSTER PUMP	35	EOP	EMERGENCY OIL PUMP
16	BFP	BOILER FEED PUMP	36	JOP	JACKING OIL PUMP
17	D/A	DEAERATOR	37	TDG	TOP OF GRATING
18	LPH	LOW PRESSURE HEATER	38	PHE	PLATE HEAT EXCHANGER
19	HPH	HIGH PRESSURE HEATER	39	SCS	SELF CLEAN STRAINER
20	VD	VENTILATION DUCT	40	DMCW	DE-MINERALISED COOLING WATER



PLAN AT 29.5M



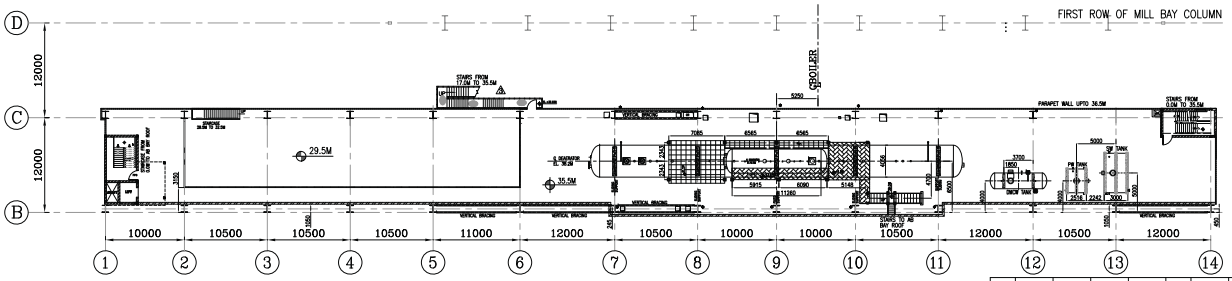
PLAN AT 27.5M

NOTES:-

1. ALL DIMENSION ARE IN MM AND LEVELS ARE IN METRES.
2. ALL ELEVATION MARKED ARE W.R.T. TG HALL FINISHED FLOOR ELEVATION OF EL 0.00M WHICH CORRESPONDS TO RL(+)270.5M.
3. CABLE DUCT/TRENCH/SLIT LAYOUT IS SHOWN FOR REPRESENTATION PURPOSE ONLY. FOR DETAILS REFER ELECTRICAL DRAWING.
4. DETAILS FOR AIR WASHER ARE INDICATIVE.
5. ⚠ FOR EXACT LOCATION AND DETAILS OF DOORS, WINDOWS, ROLLING SHUTTERS ETC., RELEVANT APPROVED ARCHITECTURAL DRGS. TO BE REFERRED.

LEGENDS

	PIPE HATCH
	VERTICAL BRACING
FPD	FIRE PROOF DOOR
	GRATING
	CHEQUERED PLATE
R	REMOVABLE
	HAND RAILING
	BRICK WALL
	CONCRETE
	PARAPET WALL



PLAN AT 35.5M

REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD
3	27.12.2024	VKS Sd/-	RC Sd/-	PM Sd/-	2	14.10.2024	VKS Sd/-	RC Sd/-	PM Sd/-	1	05.08.2024	VKS Sd/-	RC Sd/-	PM Sd/-
1	DRAWING REVISED AS PER MoM HELD DURING THE MEETING DTD. 10.12.2021 AND 11.12.2024. REVISION MARKED AS ⚠				1	DRAWING BEING RESUBMITTED.				1	DRAWING REVISED AS PER HPGCL COMMENTS ON REV-0 DTD. 2.07.2024. REVISION MARKED AS ⚠			

JOB NO. 510

STATUS CONTRACT

DISTRIBUTION

PROJECT: 1X800 MW ULTRA SUPER CRITICAL EXPANSION UNIT, DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR

OWNER: HARYANA POWER GENERATION CORPORATION LTD.

OWNER'S CONSULTANT: DESEIN PRIVATE LIMITED, CONSULTING ENGINEERS, NEW DELHI

OWNER'S REVIEW CONSULTANT: DEVELOPMENT CONSULTANTS PVT. LTD., CONSULTING ENGINEERS, KOLKATA

EPC CONTRACTOR: BHARAT HEAVY ELECTRICALS LTD, NEW DELHI

BHEL UNIT: BHARAT HEAVY ELECTRICALS LTD, POWER SECTOR PROJECT ENGINEERING MANAGEMENT,NOIDA

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DEPT CODE		NAME	SIGN	DATE
MPL	DRN	VKS		20.06.2024
	DESN	RC		20.06.2024
	CHD	RC		20.06.2024
	APPD	BKA		20.06.2024

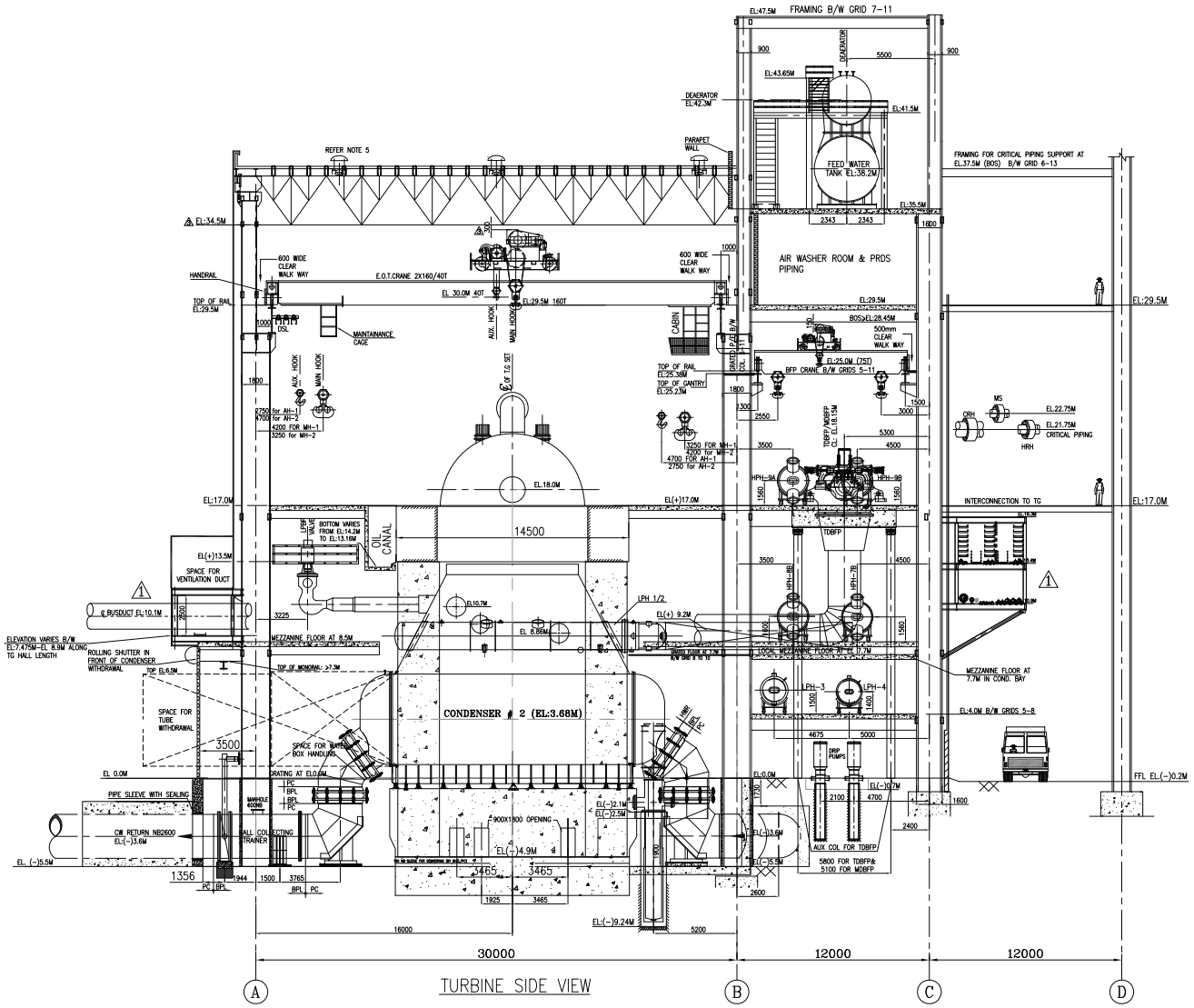
TITLE:- TG EQUIPMENT PLAN AT MISCELLANEOUS FLOORS ABOVE OPERATING FLOOR IN BC BAY

DEPT. | SCALE 1:225 | SIGN | DRAWING NO. PE-DG-510-100-M006

SHEET 1 OF 1 | REV. 3

SIZE-A0

COMPUTER FILE NAME: 510-100-M006



REFERENCE DRGS:

SL No.	TITLE	NUMBER	UNIT
1.	TG EQUIPMENT PLAN AT EL 0.0 M	PE-DG-510-100-M003	PEM
2.	TG EQUIPMENT PLAN AT EL8.5 M	PE-DG-510-100-M004	PEM
3.	TG EQUIPMENT PLAN AT EL17.0 M	PE-DG-510-100-M005	PEM
4.	TG EQUIPMENT PLAN AT MISCELLANEOUS FLOORS IN BC BAY	PE-DG-510-100-M006	PEM

ABBREVIATION LIST

SL. NO.	ABBREVIATION	FULL FORM	SL. NO.	ABBREVIATION	FULL FORM
1	EOT	ELECTRONIC OVERHEAD TRAVEL	21	LV SWGR	LOW VOLTAGE SWITCHGEAR
2	MS	MAIN STEAM	22	PW	POTABLE WATER
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4	HRH	HOT REHEAT	24	CPU	CONDENSATE POLISHING UNIT
5	LPBP	LOW PRESSURE BYPASS	25	VFD	VARIABLE FREQUENCY DRIVE
6	HPBP	HIGH PRESSURE BYPASS	26	HPSU	HIGH PRESSURE OIL SUPPLY UNIT
7	CW	COOLING WATER	27	ESV	EMERGENCY STOP VALVE
8	HVAC	HEATING & VENTILATION AIR CONDITIONING	28	IV	INTERCEPTOR VALVE
9	MCC	MOTOR CONTROL	29	OLV	OVER LOAD VALVE
10	AHU	AIR HANDLING UNIT	30	F/T	FLASH TANK
11	FPD	FIRE PROOF DOOR	31	GSC	GLAND STEAM CONDENSOR
12	CR	CABLE RISER	32	SWAS	STEAM AND WATER ANALYSIS ROOM
13	PRDS	PRESSURE REDUCING DE-SUPER HEATING STATION	33	DOT	DIRTY OIL TANK
14	RS	ROLLING SHUTTER	34	COT	CLEAN OIL TANK
15	BP	BOOSTER PUMP	35	EOP	EMERGENCY OIL PUMP
16	BFP	BOILER FEED PUMP	36	JOP	JACKING OIL PUMP
17	D/A	DEAREATOR	37	TOG	TOP OF GRATING
18	LPH	LOW PRESSURE HEATER	38	PHE	PLATE HEAT EXCHANGER
19	HPH	HIGH PRESSURE HEATER	39	SCS	SELF CLEAN STRTAINER
20	VD	VENTILATION DUCT	40	DMCW	DE-MINERALISED COOLING WATER

LEGENDS

	VERTICAL BRACING
FPD	FIRE PROOF DOOR
	GRATING
	CHEQUERED PLATE
Ⓡ	REMOVABLE
	HAND RAILING
	FIRE BARRIER WALL

NOTES:-

1. ALL DIMENSION ARE IN MM AND LEVELS ARE IN METRES.
2. ALL ELEVATION MARKED ARE W.R.T. TG HALL FINISHED FLOOR ELEVATION OF EL 0.0M WHICH CORRESPONDS TO RL(+)270.5M.
3. ALL THE SIZES AND LOCATION OF COLUMNS OF TG DECK ARE SUBJECT TO FINALIZATION AFTER CIVIL DESIGN.
4. SIZES OF ALL TG BUILDING MAIN AND AUXILIARY COLUMNS ARE SUBJECT TO CIVIL DESIGN.
5. DETAILS OF TG BUILDING ROOF EXHAUSTERS ARE INDICATIVE. FOR DETAILS REFER RESPECTIVE VENTILATION AREA DRAWING.

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COMPUTER FILE NAME: 510-100-M007

REV.	DATE	ALTD	CHD	APPD
3	27.12.2024	VKS Sd/-	RC Sd/-	PM Sd/-
1	DRAWING REVISED AS PER MoM HELD DURING THE MEETING DTD. 10.12.2021 AND 11.12.2024. REVISION MARKED AS A			

REV.	DATE	ALTD	CHD	APPD
2	14.10.2024	VKS Sd/-	RC Sd/-	PM Sd/-
1	DRAWING BEING RESUBMITTED.			

REV.	DATE	ALTD	CHD	APPD
1	05.08.2024	VKS Sd/-	RC Sd/-	PM Sd/-
1	DRAWING REVISED AS PER HPGCL COMMENTS ON REV-0 DTD. 2.07.2024. REVISION MARKED AS A			

JOB NO. 510
STATUS CONTRACT
DISTRIBUTION

PROJECT: 1X800 MW ULTRA SUPER CRITICAL EXPANSION UNIT, DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR

OWNER: HARYANA POWER GENERATION CORPORATION LTD.

OWNER'S CONSULTANT: DESEIN PRIVATE LIMITED, CONSULTING ENGINEERS, NEW DELHI

OWNER'S REVIEW CONSULTANT: DEVELOPMENT CONSULTANTS PVT. LTD., CONSULTING ENGINEERS, KOLKATA

EPC CONTRACTOR: BHARAT HEAVY ELECTRICALS LTD, NEW DELHI

BHEL UNIT: BHARAT HEAVY ELECTRICALS LTD, POWER SECTOR PROJECT ENGINEERING MANAGEMENT,NOIDA

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DEPT CODE		NAME	SIGN	DATE
MPL	DRN	VKS		20.06.2024
	DESN	RC		20.06.2024
	CHD	RC		20.06.2024
	APPD	BKA		20.06.2024

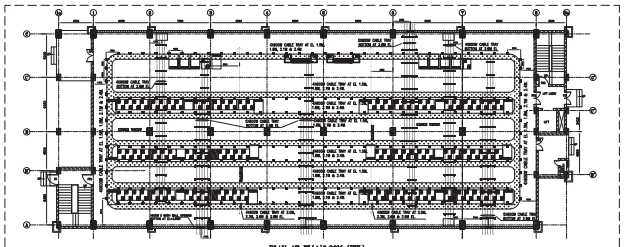
TITLE:-
CROSS SECTION OF MAIN PLANT (TG BUILDING)

DEPT. | SCALE 1:225 | DRAWING NO. PE-DG-510-100-M007
SIGN | SHEET 1 OF 1 | REV. 3

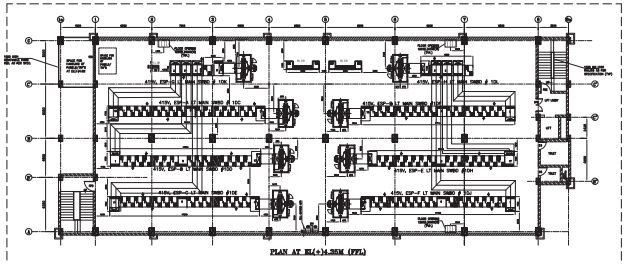
SIZE-A0

DRAWING NO. PE-DG-510-100-R006

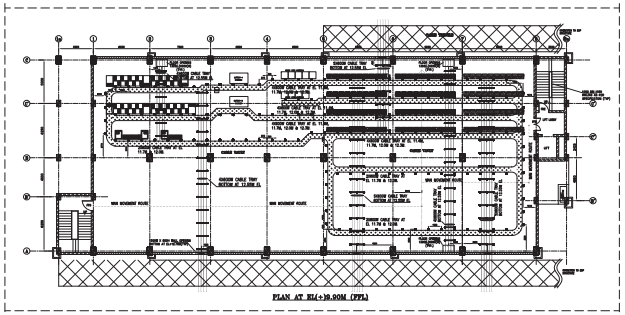
NORTH
TRUE NORTH



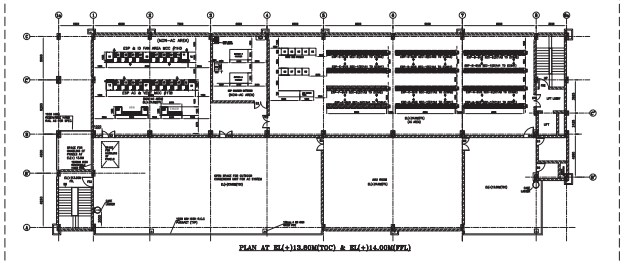
PLAN AT EL(+)0.00M (FFL)



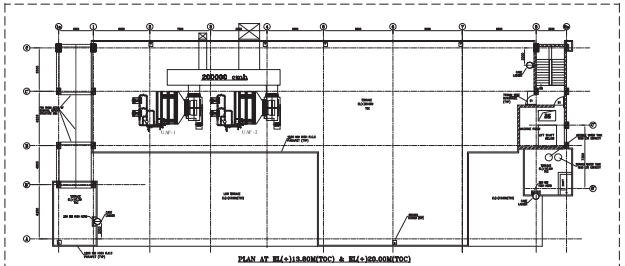
PLAN AT EL(+)4.35M (FFL)



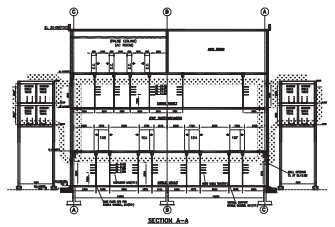
PLAN AT EL(+)9.00M (FFL)



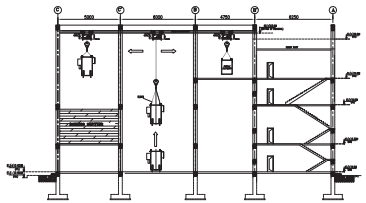
PLAN AT EL(+)13.80M(TOC) & EL(+)14.00M(FFL)



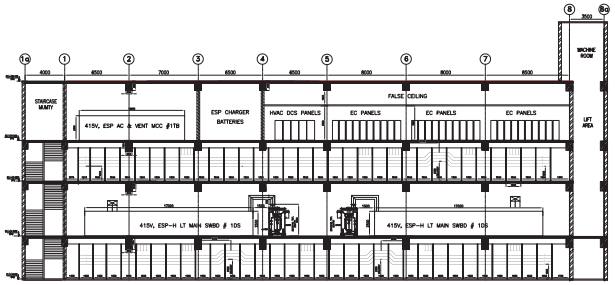
PLAN AT EL(+)13.80M(TOC) & EL(+)20.00M(TOC)



SECTION A-A



SECTION B-B



SECTION C-C

EQUIPMENTS DETAILS AT 4.35M EL (TENTATIVE)

S.NO.	DESCRIPTION	DESIGNATION	SIZE(MM) LXDXH	SCOPE
01	ESP-A LT MAIN SWBD	1DC	18000X1700X2425	PEM
02	ESP-B LT MAIN SWBD	1DD	17300X1700X2425	PEM
03	ESP-C LT MAIN SWBD	1DE	17250X1700X2425	PEM
04	ESP-D LT MAIN SWBD	1DK	6000X1700X2425	PEM
05	ESP-E LT MAIN SWBD	1DF	16800X1700X2425	PEM
06	ESP-F LT MAIN SWBD	1DH	16800X1700X2425	PEM
07	ESP-G LT MAIN SWBD	1DJ	17750X1700X2425	PEM
08	ESP-H LT MAIN SWBD	1DL	6000X1700X2425	PEM
09	ESP LT TRF(11/0.433kV) -AN	08 NOS.	3200X1750X3000	JHANSI
10	WALL MOUNTED DB'S	DC FUSE DB-1,2	650X300X700	PEM
11	MLDB & WDB	----	3800X1000X2100	PEM
12	DC LDB	----	750X350X1175	PEM
13	EMLDB	----	2400X1000X1175	PEM

EQUIPMENTS DETAILS AT 14.0M EL (TENTATIVE)

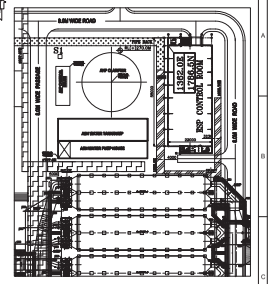
S.NO.	DESCRIPTION	DESIGNATION	SIZE(MM) LXDXH	SCOPE
01	415V ESP AC & VENT MCC	1TB	10250X1200X2425	PEM
02	415V ESP & ID FAN AREA MCC	1HD	9400X1200X2425	PEM
03	EC PANELS (120 NOS)	----	600X550X2067	BHOPAL
04	HVAC DCS PANELS (09 NOS)	----	800X800X2067	PEM
05	ESP CHARGER PANEL	----	800X800X2067	PEM
06	ESP CHARGER BATTERIES	----	2100X1200X890	EDN
07	BHMS (ESP CHARGER BATTERIES)	----	600X500X1400	EDN
08	AHU EQUIPMENTS	----	----	PEM
09	OUTDOOR UNIT FOR AC SYSTEM	----	----	PEM

EQUIPMENTS DETAILS AT 20.0M EL (TENTATIVE)

S.NO.	DESCRIPTION	DESIGNATION	SIZE(MM) LXDXH	SCOPE
01	VENTILATION EQPT. (UAF&PUMP)	----		PEM

LEGEND

- OPERATING FRONT OF THE PANEL
- FPD — SINGLE LEAF FIRE PROOF DOOR (1200Wx2100H)
- FPD — DOUBLE LEAF FIRE PROOF DOUR (1500Wx2100H)
- D3Y — DOUBLE LEAF FIRE PROOF DOOR (2000Wx2100H) PLUS 900 HIGH REMOVABLE TRANSOM
- BRICK WALL
- HORIZONTAL CABLE TRAY
- VERTICAL CABLE TRAY
- ROLLING SHUTTER(3500MMX3500MM)
- WALL CUTOUT
- DUMMY PANEL



KEY PLAN

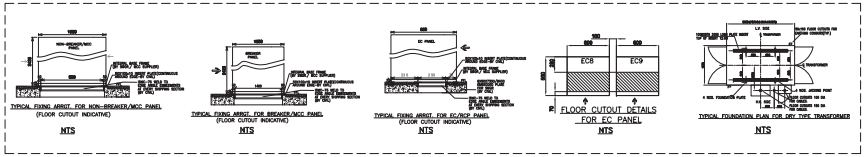
REFERENCE DRAWINGS :

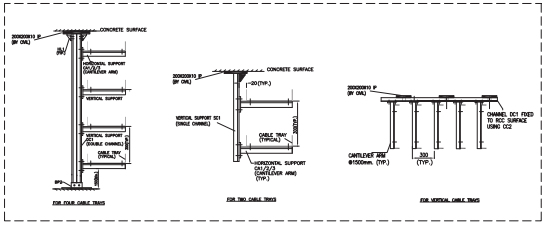
SL NO	TITLE	DRG NO	SOURCE
1.	PLOT PLAN	PE-DG-510-100-M001	PEM/MECH
2.	MAIN PLANT EQUIPMENT LAYOUT PLAN AT 0.0M	PE-DG-510-100-M002	PEM/MECH
3.	ELECTRICAL SINGLE LINE DIAGRAM	PE-DG-510-565-E001	PEM/MECH
4.	CABLE ERECTION PHILOSOPHY	PE-DC-510-507-E004	PEM/ELECT
5.	TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES	PE-DG-510-507-E005	PEM/ELECT
6.	INSTALLATION DETAILS OF CABLE TRAYS SUPPORT SYSTEM	PE-DG-510-507-E006	PEM/ELECT
7.	DESIGN PHILOSOPHY FOR ELECTRICAL EQUIPMENT LAYOUT	PE-DC-510-100-E101	PEM/ELECT
8.	OGA 2000kVA, 11kV/433V DRY TYPE TRANSFORMER	----------	BHEL/JHANSI
9.	OGA 2000kVA, 11kV/433V DRY TYPE TRANSFORMER(MIRROR)	----------	BHEL/JHANSI
10.	RECOMMENDED ESP CONTROL ROOM LAYOUT	RECEIVED VIDE MAIL DTD-05.11.24	BHEL/ RANIPET
11.	GA OF LTMSB-1DC/1DD/1DE/1DF/1DH/1DJ/1DS/2DS	----------	BHEL/ RANIPET
12.	ELECTRONIC CONTROLLER(EC) PANELS	----------	BHEL/ BHOPAL
13.	GA OF ESP & ID FAN AREA MCC #1HD	----------	PEM/ELECT
14.	GA OF ESP AC & VENT. MCC #1TB	----------	PEM/ELECT
15.	GA OF LDB (NORMAL & EMERGENCY)	----------	PEM/ELECT
16.	GA OF DC LDB	----------	PEM/ELECT
17.	AC DUCT LAYOUT DRG FOR ESP WITH AHU/PU RM LAYOUT WITH FOUNDATION DETAILS FOR INDOOR & OUTDR UNITS	PE-VD-510-553-AXXX	PEM/MAUX
18.	VENTILATION DUCT LAYOUT FOR ESP SWGR CUM CONTROL BLDG	PE-DG-510-554-AG27	PEM/MAUX
19.	ESP CONTROL ROOM GA & RC DETAILS OF ROOF/FLOORS	PE-DG-510-619-C3XX	PEM/CIVIL
20.	ESP CONTROL BLDG ARCHITECTURAL PLAN	PE-DG-510-619-C1XX	PEM/CIVIL

NOTES :

NOTES:

1. ALL DIMENSIONS ARE IN MM AND ELEVATIONS IN METRES.
2. ALL ELEVATIONS MARKED ARE W.R.T. FINISHED FLOOR LEVEL (FFL) OF POWER HOUSE BUILDING GROUND FLOOR IS EL. 0.00M WHICH CORRESPONDS TO RL. 270.5M ABOVE FSL.
3. FOR MOUNTING & FOUNDATION DETAILS AND FLOOR CUTOUTS RESPECTIVE DRAWINGS SHOWN IN 'REFERENCE DRAWINGS' SHALL BE REFERRED.
4. THIS DRAWING IS TO BE REFERRED FOR DETAILS OF ELECTRICAL EQUIPMENT AND CABLING LAYOUT ONLY. LAYOUT SHOWN FOR FACILITIES SUCH AS AC & VENTILATION SYSTEM IS INDICATIVE AND FOR INTERFACE PURPOSE. FOR EXACT LAYOUT OF OTHER SYSTEMS, RELEVANT DISCIPLINE DRAWINGS SHALL BE REFERRED.
5. ALL AREAS SHOWN IN THIS DRAWING ARE NON A/C UNLESS STATED OTHERWISE.
6. THIS DRAWING IS PREPARED FOR FREEZING BASIC BUILDING DIMENSION. EQUIPMENT SIZES SHOWN ARE INDICATIVE ONLY & WILL BE FINALIZED AFTER RECEIPT OF GOA'S OF VARIOUS EQUIPMENT FROM RESPECTIVE AGENCY.
7. BOTTOMMOST ONE TRAY OF ALL RUNS SHALL BE PERFORATED TYPE.
8. THIS DRAWING IS PREPARED FOR FREEZING BASIC BUILDING DIMENSION. EQUIPMENT SIZES SHOWN ARE INDICATIVE ONLY & WILL BE FINALIZED AFTER RECEIPT OF GOA'S OF VARIOUS EQUIPMENT FROM RESPECTIVE AGENCY.
9. CABLE TRAYS & SUPPORTS INSTALLATION SHALL BE DONE AS PER REF. DRG. NO. 4, 5 & 6.
10. RATING OF FIRE PROOF DOOR TO BE PROVIDED IN CABLE VAULT SHALL BE 2 HOURS.
11. ALL FLOOR OPENING TO BE SEALED WITH FSC AFTER PANEL ERECTION AND TERMINATION OF CABLES.
12. EMBEDDED PLATES AS REQUIRED FOR CABLE TRAY SUPPORTING ARRANGEMENT AND ISMC AS REQUIRED IN FIXING ARRANGEMENT FOR PMCC/MCC PANEL SHALL BE IN PEM-CIVIL SCOPE.
13. HV & LV POWER CABLES SHALL BE LAID IN LADDER TYPE CABLE TRAYS. CONTROL & INSTRUMENTATION CABLES SHALL BE LAID IN PERFORATED TRAYS. HOWEVER IN VERTICAL RISERS CONTROL & INSTRUMENTATION CABLES SHALL BE LAID IN LADDER TYPE TRAYS.
14. DUMMY PANELS, IF REQUIRED SHALL BE PROVIDED WHEREVER BEAM HAPPENS TO CROSS THE PANEL CUTOUT.
15. SWITCHGEAR ROOM SHALL BE PROVIDED WITH HIGH VOLTAGE DIELECTRIC FLOORING.
16. SW/FW TANKS DETAILS AS REQUIRED FOR THE BUILDING SHALL BE COVERED IN CIVIL ARCHITECTURAL DRAWING SEPARATELY.





TYPICAL CABLE TRAYS INSTALLATION DETAILS (IN CABLE VAULT)

BILL OF QUANTITY FOR TRAYS,TRAY SUPPORT & ACCES

S. NO.	MATERIAL DESCRIPTION	UNIT	QUANTITY
1	CABLE TRAY 600MM WIDE (LADDER TYPE)	METRES	2475
2	CABLE TRAY 600MM WIDE (PERFORATED TYPE)	METRES	865
3	CABLE TRAY 300MM WIDE (LADDER TYPE)	METRES	60
4	CABLE TRAY 300MM WIDE (PERFORATED TYPE)	METRES	40
5	CABLE TRAY 100MM WIDE	METRES	40
6	CANTILEVER ARM (620MM WIDE) FOR 600MM WIDE CABLE TRAYS (CA1)	NOS.	1355
7	CANTILEVER ARM (320MM WIDE) FOR 300MM WIDE CABLE TRAYS (CA3)	NOS.	65
8	CANTILEVER ARM (170MM WIDE) FOR 150MM WIDE CABLE TRAYS (CA4)	NOS.	40
9	90' HORIZONTAL BEND FOR 600M TRAY (LADDER TYPE)	NOS.	96
10	90' HORIZONTAL BEND FOR 600M TRAY (PERFORATED TYPE)	NOS.	18
11	TEE FOR 600M TRAY (LADDER TYPE)	NOS.	61
12	TEE FOR 600M TRAY (PERFORATED TYPE)	NOS.	20
13	SINGLE CHANNEL (SC1)	METRES	200
14	DOUBLE CHANNEL (DC1)	METRES	80
15	BASE PLATE FOR DOUBLE CHANNEL(BP2)	NOS.	15
16	BASE PLATE FOR SINGLE CHANNEL(BP1)	NOS.	45
19	HEAVY DUTY RIGHT ANGLE FITTING HL1	NOS.	60

REV	DATE	A/CD	CHD	APPD
03	05.02.25	UP/LP	RKS	AS
02	24.12.25	CR	RKS	AS
01	04.10.25	CR	RKS	AS

REV	DESCRIPTION
0	ISSUED AS PER CUSTOMER COMMENTS.
1	ISSUED AS PER CUSTOMER COMMENTS.
2	ISSUED AS PER CUSTOMER COMMENTS.
3	ISSUED AS PER CUSTOMER COMMENTS.
4	ISSUED AS PER CUSTOMER COMMENTS.
5	ISSUED AS PER CUSTOMER COMMENTS.

CUSTOMER: HARYANA POWER GENERATION CORPORATION LTD.

CONSULTANT: DESEIN PRIVATE LIMITED
CONSULTING ENGINEERS, NEW DELHI, INDIA

1x800MW DEEN BANDHU CHOTU RAM
SUPER THERMAL POWER PLANT, YAMUNA NAGAR

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA

JOB NO. 510
STATUS CONTRACT
DISTRIBUTION

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	DEPT	NAME	SIGN	DATE
E	CODE	DR/BY	—/R—	11.03.2025
	DSGN	CR	—/R—	11.03.2025
	CHD	RKS	—/R—	11.03.2025
	APPD	AS	—/R—	11.03.2025

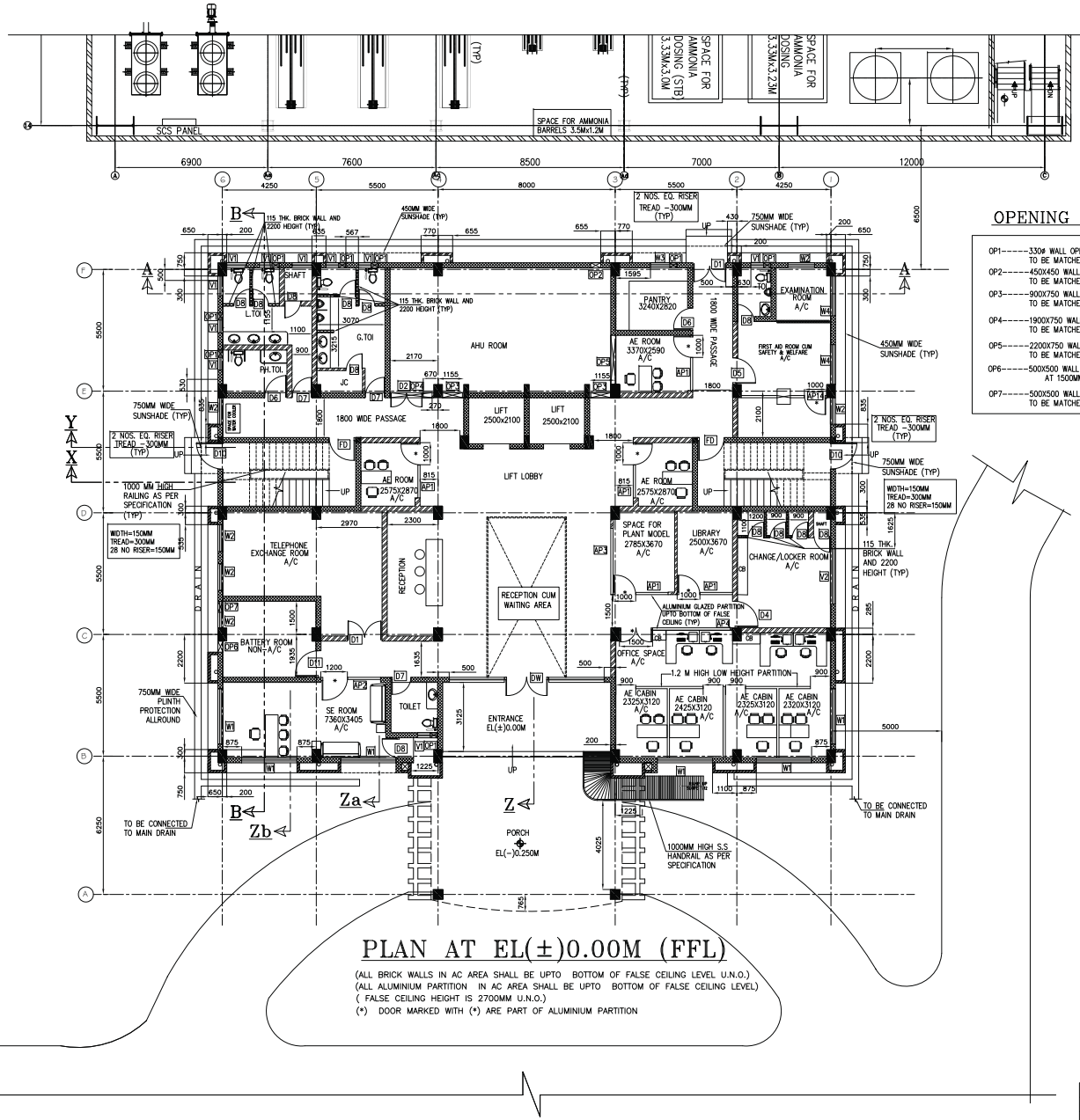
TITLE: ELECT EQPT. & CABLING LAYOUT IN ESP SWGR CUM CONTROL BLDG.

DEPT. | SCALE | SIGN | DRAWING NO. PE-DG-510-100-R006 | SHEET 1 OF 1 | REV. 03

SIZE-A0

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COMPUTER FILE PANEL



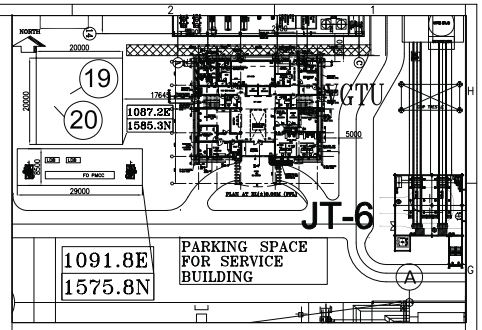
PLAN AT EL(±)0.00M (FFL)

(ALL BRICK WALLS IN AC AREA SHALL BE UPTO BOTTOM OF FALSE CEILING LEVEL U.N.O.)
(ALL ALUMINIUM PARTITION IN AC AREA SHALL BE UPTO BOTTOM OF FALSE CEILING LEVEL)
(FALSE CEILING HEIGHT IS 2700MM U.N.O.)
(*) DOOR MARKED WITH (*) ARE PART OF ALUMINIUM PARTITION

OPENING SCHEDULE

OP1------330# WALL OPENING, BOTTOM OF OPENING TO BE MATCHED WITH TOP OF LINTEL BEAM
OP2------450X450 WALL OPENING ,BOTTOM OF OPENING TO BE MATCHED WITH TOP OF LINTEL BEAM
OP3------900X750 WALL OPENING, TOP OF OPENING TO BE MATCHED WITH BOTTOM OF FLOOR BEAM
OP4------1900X750 WALL OPENING, TOP OF OPENING TO BE MATCHED WITH BOTTOM OF FLOOR BEAM
OP5------2200X750 WALL OPENING, TOP OF OPENING TO BE MATCHED WITH BOTTOM OF FLOOR BEAM
OP6------500X500 WALL OPENING BOTTOM OF OPENING AT 1500MM FROM FFL.
OP7------500X500 WALL OPENING ,BOTTOM OF OPENING TO BE MATCHED WITH TOP OF LINTEL BEAM

CABIN	NUMBER
SE ROOM	01.NO
EE ROOM	–
AE ROOM	07.NO
MEETING ROOM	–



NOTES:–

1. ALL DIMENSIONS ARE IN MILLIMETERS EXCEPT FLOOR ELEVATIONS AND PLANT GRID WHICH ARE IN METERS, UNLESS STATED OTHERWISE.
2. EL(±)0.000 REFERS TO FINISHED FLOOR LEVEL OF POWER HOUSE BUILDING WHICH CORRESPONDS TO RL(+)270.500 M.
3. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH THE RELEVANT ARCHITECTURAL, CIVIL AND STRUCTURAL DRAWINGS, SPECIFICATIONS & SCHEDULE OF ITEMS.
4. DOOR MARKED AS (*) ARE PART OF ALUMINIUM PARTITION.
5. ANODIZED ALUMINIUM GRILL SHOULD BE PROVIDED TO ALL WINDOWS AT GROUND FLOOR.

KEY PLAN

REFERENCE DRAWINGS:–

1. SERVICE BLDG –ARCH .GA AT FIRST FLOOR LEVEL --------PE-DG-510-640-C002
2. SERVICE BLDG –ARCH .GA AT SECOND FLOOR LEVEL -------PE-DG-510-640-C003
3. SERVICE BLDG –ARCH .GA AT THIRD FLOOR LEVEL --------PE-DG-510-640-C004
4. SERVICE BLDG –ARCH .GA AT FOURTH FLOOR LEVEL -------PE-DG-510-640-C005
5. SERVICE BLDG –ARCH .GA AT ROOF LEVEL ----------PE-DG-510-640-C006

LEGENDS

S.NO	LEGEND	DESCRIPTION
1.	TYP.	TYPICAL
2.	THK.	THICK
3.	FFL	FINISH FLOOR LEVEL
4.	BOL	BOTTOM OF LINTEL
5.	LVL	LEVEL
6.	TOC	TOP OF CONCRETE
7.	TOP	TOP OF PARAPET WALL
8.	FGL	FINISHED GROUND LEVEL
9.		230 THICK BRICK WALL UPTO BOTTOM OF FALSE CEILING
10.		115 THK BRICK WALL UPTO 2200
11.		230 THICK BRICK WALL UPTO SLAB LVL
12.		450 HIGH KERB WALL
13.		115 THICK BRICK WALL IN PIPE SHAFT
14.	RWP	150mm ø MS RAIN WATER PIPE

BHEL-PROJECT ENGINEERING MANAGEMENT(CIVIL)
THIS DRAWING MARKED(✓) IS RELEASED FOR
☒ COMMENTS/APPROVAL
☐ PLANNING/INFORMATION
☐ CONSTRUCTION
STAMP ALL PREVIOUS REVISION AS SUPERSEDED

ISSUED BY	
NAME	MK MAHALA
SIGNATURE	–sd–
DATE	31.10.2025

REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD
04	31.10.25	USHA	S.B	TMSR	03	15.07.25	USHA	S.B	TMSR	02	07.02.25	USHA	S.B	MKM	01	14.10.24	USHA	S.B	MKM
	DRAWING REVISED AS PER CUSTOMER COMMENTS AND COMMENTS RECEIVED DURING VC MEETING HELD ON 17.10.2025 BETWEEN HPGCL, DCPL, DESEIN AND BHEL					REVISED AS PER APPROVED 3–D PERSPECTIVE VIEW AND CUSTOMER COMMENTS					GENERALLY REVISED					REVISED AS PER CUSTOMER COMMENTS			

JOB NO. 510
STATUS CONTRACT
DISTRIBUTION

PROJECT
1X800 MW ULTRA SUPER CRITICAL EXPANSION UNIT, DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR

OWNER: HARYANA POWER GENERATION CORPORATION LTD.
OWNER'S CONSULTANT: DESEIN PRIVATE LIMITED, CONSULTING ENGINEERS, NEW DELHI
OWNER'S REVIEW CONSULTANT: DEVELOPMENT CONSULTANTS PVT. LTD., CONSULTING ENGINEERS, KOLKATA
EPC CONTRACTOR: BHARAT HEAVY ELECTRICALS LTD, NEW DELHI
BHEL UNIT: BHARAT HEAVY ELECTRICALS LTD, POWER SECTOR PROJECT ENGINEERING MANAGEMENT,NOIDA
SUB-SUPPLIER / SUB-VENDOR: XXXX

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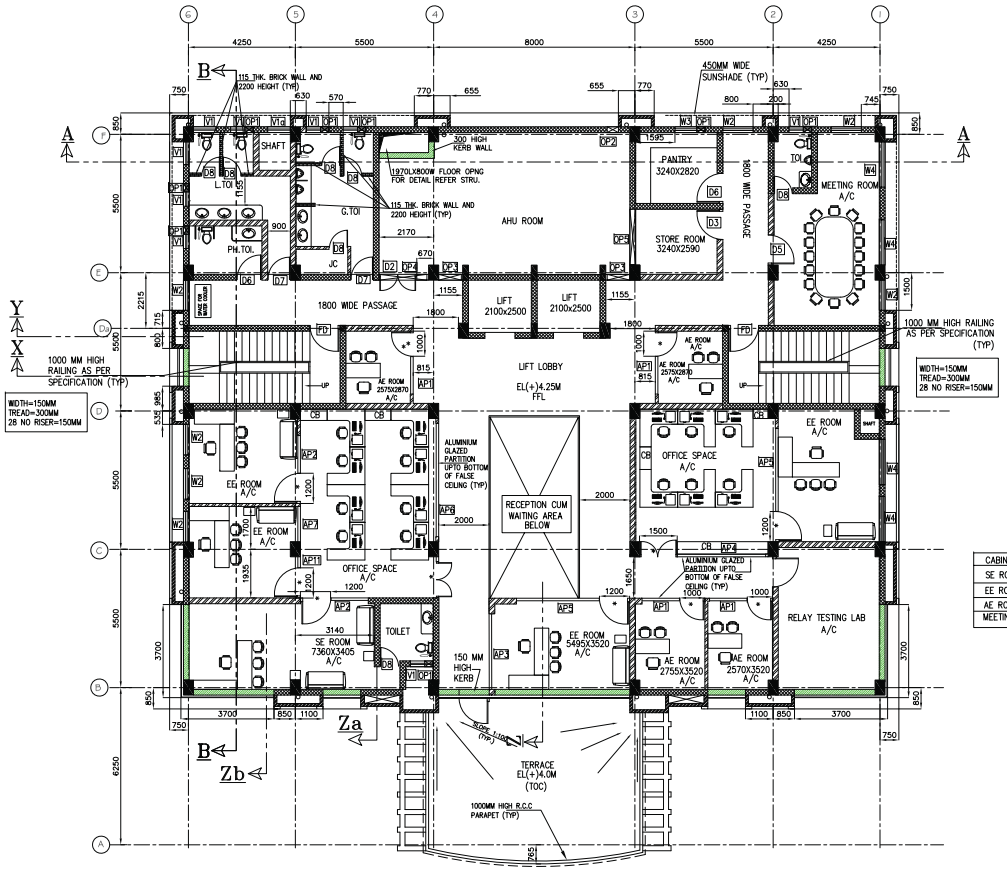
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	DESN	S.BAJPAI	–sd–	06.08.2024
	CHD	MKM	–sd–	06.08.2024
	APPD	AM	–sd–	06.08.2024

TITLE –
SERVICE BUILDING
ARCH. GA AT GROUND LEVEL

DEPT. | SCALE | DRAWING NO. PE-DG-510-640-C001
SIGN
SHEET 1 OF 1 REV. 04

Jul 18, 2026 – 4:53pm SIZE–A0

Page 556 of 563



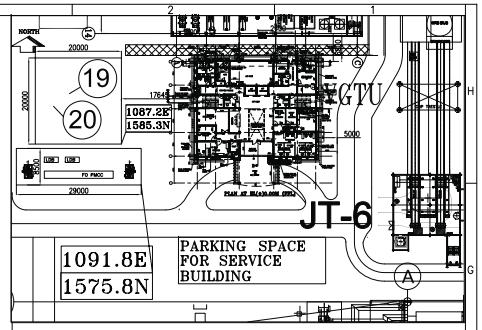
CABIN	NUMBER
SE ROOM	01.NO
EE ROOM	04.NO
AE ROOM	04.NO
MEETING ROOM	01.NO

PLAN AT EL(+)4.25 (FFL)

(ALL BRICK WALLS IN AC AREA SHALL BE UPTO BOTTOM OF FALSE CEILING LEVEL U.N.O.)
(ALL ALUMINIUM PARTITION IN AC AREA SHALL BE UPTO BOTTOM OF FALSE CEILING LEVEL)
(FALSE CEILING HEIGHT IS 2400MM U.N.O.)
(*) DOOR MARKED WITH (*) ARE PART OF ALUMINIUM PARTITION

OPENING SCHEDULE

OP1-----330ø WALL OPENING, BOTTOM OF OPENING TO BE MATCHED WITH TOP OF LINTEL BEAM
OP2-----450X450 WALL OPENING ,BOTTOM OF OPENING TO BE MATCHED WITH TOP OF LINTEL BEAM
OP3-----900X750 WALL OPENING, TOP OF OPENING TO BE MATCHED WITH BOTTOM OF FLOOR BEAM
OP4-----1900X750 WALL OPENING, TOP OF OPENING TO BE MATCHED WITH BOTTOM OF FLOOR BEAM
OP5-----2200X750 WALL OPENING, TOP OF OPENING TO BE MATCHED WITH BOTTOM OF FLOOR BEAM



KEY PLAN

NOTES:–

1. ALL DIMENSIONS ARE IN MILLIMETERS EXCEPT FLOOR ELEVATIONS AND PLANT GRID WHICH ARE IN METERS, UNLESS STATED OTHERWISE.
2. EL(±)0.000 REFERS TO FINISHED FLOOR LEVEL OF POWER HOUSE BUILDING WHICH CORRESPONDS TO RL(+)270.500 M.
3. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH THE RELEVANT ARCHITECTURAL, CIVIL AND STRUCTURAL DRAWINGS, SPECIFICATIONS & SCHEDULE OF ITEMS.
4. DOOR MARKED AS (*) ARE PART OF ALUMINIUM PARTITION.
5. ANODIZED ALUMINIUM GRILL SHOULD BE PROVIDED TO ALL WINDOWS AT GROUND FLOOR.

REFERENCE DRAWINGS:–

1. SERVICE BLDG –ARCH .GA AT GROUND FLOOR LEVEL -----PE-DG-510-640-C001
2. SERVICE BLDG –ARCH .GA AT SECOND FLOOR LEVEL ------PE-DG-510-640-C003
3. SERVICE BLDG –ARCH .GA AT THIRD FLOOR LEVEL --------PE-DG-510-640-C004
4. SERVICE BLDG –ARCH .GA AT FOURTH FLOOR LEVEL -------PE-DG-510-640-C005
5. SERVICE BLDG –ARCH .GA AT ROOF LEVEL ----------PE-DG-510-640-C006

LEGENDS

S.NO	LEGEND	DESCRIPTION
1.	TYP.	TYPICAL
2.	THK.	THICK
3.	FFL	FINISH FLOOR LEVEL
4.	BOL	BOTTOM OF LINTEL
5.	LVL	LEVEL
6.	TOC	TOP OF CONCRETE
7.	TOP	TOP OF PARAPET WALL
8.	FGL	FINISHED GROUND LEVEL
9.		230 THICK BRICK WALL UPTO BOTTOM OF FALSE CEILING
10.		115 THK BRICK WALL UPTO 2200
11.		230 THICK BRICK WALL UPTO SLAB LVL
12.		450 HIGH KERB WALL
13.		115 THICK BRICK WALL IN PIPE SHAFT
14.	RWP	150mm ø MS RAIN WATER PIPE

BHEL-PROJECT ENGINEERING MANAGEMENT(CIVIL)
THIS DRAWING MARKED(✓) IS RELEASED FOR
☑ COMMENTS/APPROVAL
☐ PLANNING/INFORMATION
☐ CONSTRUCTION
STAMP ALL PREVIOUS REVISION AS SUPERSEDED
ISSUED BY
NAME: MK MAHALA
SIGNATURE: –sd–
DATE: 31.10.2025

REV.	DATE	ALTD	CHD	APPD	REMARKS
04	31.10.25	USHA	S.B	TMSR	DRAWING REVISED AS PER CUSTOMER COMMENTS AND COMMENTS RECEIVED DURING VC MEETING HELD ON 17.10.2025 BETWEEN HPGCL, DCPL, DESEIN AND BHEL
03	15.07.25	USHA	S.B	TMSR	REVISED AS PER APPROVED 3-D PERSPECTIVE VIEW AND CUSTOMER COMMENTS
02	07.02.25	USHA	S.B	MKM	GENERALLY REVISED
01	14.10.24	USHA	S.B	MKM	REVISED AS PER CUSTOMER COMMENTS

JOB NO. 510
STATUS CONTRACT
DISTRIBUTION

PROJECT: 1X800 MW ULTRA SUPER CRITICAL EXPANSION UNIT, DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR

OWNER: HARYANA POWER GENERATION CORPORATION LTD.

OWNER'S CONSULTANT: DESEIN PRIVATE LIMITED, CONSULTING ENGINEERS, NEW DELHI

OWNER'S REVIEW CONSULTANT: DEVELOPMENT CONSULTANTS PVT. LTD., CONSULTING ENGINEERS, KOLKATA

EPC CONTRACTOR: BHARAT HEAVY ELECTRICALS LTD, NEW DELHI

BHEL UNIT: BHARAT HEAVY ELECTRICALS LTD, POWER SECTOR PROJECT ENGINEERING MANAGEMENT,NOIDA

SUB-SUPPLIER / SUB-VENDOR: XXXX

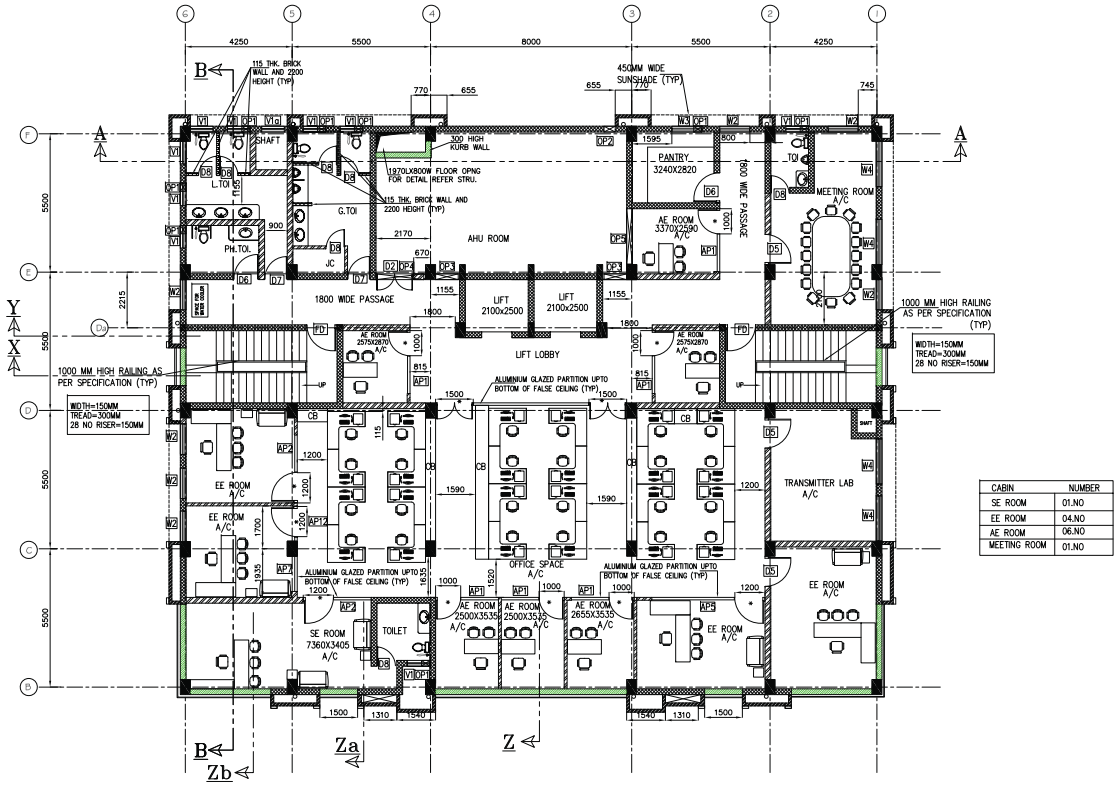
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DEPT CODE		NAME	SIGN	DATE
C	DRN	USHA	–sd–	06.08.2024
	DESN	S.BAJPAI	–sd–	06.08.2024
	CHD	MKM	–sd–	06.08.2024
	APPD	AM	–sd–	06.08.2024

TITLE –
SERVICE BUILDING
ARCH. GA AT FIRST LEVEL

DEPT. | SCALE | DRAWING NO. PE-DG-510-640-C002
SIGN
SHEET 1 OF 1 REV. 04

Jul 18, 2026 – 4:53pm SIZE–A0



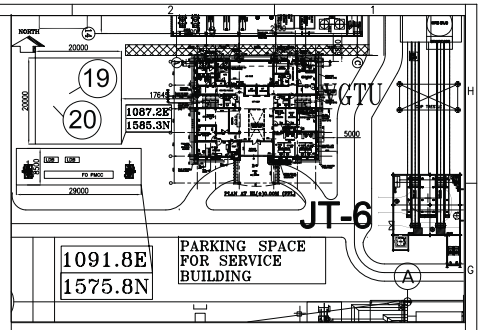
CABIN	NUMBER
SE ROOM	01.NO
EE ROOM	04.NO
AE ROOM	06.NO
MEETING ROOM	01.NO

PLAN AT EL(+)8.50 (FFL)

(ALL BRICK WALLS IN AC AREA SHALL BE UPTO BOTTOM OF FALSE CEILING LEVEL U.N.O.)
(ALL ALUMINIUM PARTITION IN AC AREA SHALL BE UPTO BOTTOM OF FALSE CEILING LEVEL)
(FALSE CEILING HEIGHT IS 2400MM U.N.O.)
(*) DOOR MARKED WITH (*) ARE PART OF ALUMINIUM PARTITION

OPENING SCHEDULE

OP1------330# WALL OPENING, BOTTOM OF OPENING TO BE MATCHED WITH TOP OF LINTEL BEAM
OP2------450X450 WALL OPENING ,BOTTOM OF OPENING TO BE MATCHED WITH TOP OF LINTEL BEAM
OP3------900X750 WALL OPENING, TOP OF OPENING TO BE MATCHED WITH BOTTOM OF FLOOR BEAM
OP4------1900X750 WALL OPENING, TOP OF OPENING TO BE MATCHED WITH BOTTOM OF FLOOR BEAM
OP5------2200X750 WALL OPENING, TOP OF OPENING TO BE MATCHED WITH BOTTOM OF FLOOR BEAM



NOTES:–

1. ALL DIMENSIONS ARE IN MILLIMETERS EXCEPT FLOOR ELEVATIONS AND PLANT GRID WHICH ARE IN METERS, UNLESS STATED OTHERWISE.
2. EL(±)0.000 REFERS TO FINISHED FLOOR LEVEL OF POWER HOUSE BUILDING WHICH CORRESPONDS TO RL(+)270.500 M.
3. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH THE RELEVANT ARCHITECTURAL, CIVIL AND STRUCTURAL DRAWINGS, SPECIFICATIONS & SCHEDULE OF ITEMS.
4. TOILET INTERNAL WALL SHALL BE OF 115MM BRICK WORK AND 2200 MM HIGH.
5. DOOR MARKED AS (*) ARE PART OF ALUMINIUM PARTITION.
6. ANODIZED ALUMINIUM GRILL SHOULD BE PROVIDED TO ALL WINDOWS AT GROUND FLOOR.

KEY PLAN

REFERENCE DRAWINGS:–

1. SERVICE BLDG –ARCH .GA AT GROUND FLOOR LEVEL -----PE-DG-510-640-C001
2. SERVICE BLDG –ARCH .GA AT FIRST FLOOR LEVEL -------PE-DG-510-640-C002
3. SERVICE BLDG –ARCH .GA AT THIRD FLOOR LEVEL -------PE-DG-510-640-C004
4. SERVICE BLDG –ARCH .GA AT FOURTH FLOOR LEVEL ------PE-DG-510-640-C005
5. SERVICE BLDG –ARCH .GA AT ROOF LEVEL ----------PE-DG-510-640-C006

LEGENDS

S.NO	LEGEND	DESCRIPTION
1.	TYP.	TYPICAL
2.	THK.	THICK
3.	FFL	FINISH FLOOR LEVEL
4.	BOL	BOTTOM OF LINTEL
5.	LVL	LEVEL
6.	TOC	TOP OF CONCRETE
7.	TOP	TOP OF PARAPET WALL
8.	FGL	FINISHED GROUND LEVEL
9.		230 THICK BRICK WALL UPTO BOTTOM OF FALSE CEILING
10.		115 THK BRICK WALL UPTO 2200
11.		230 THICK BRICK WALL UPTO SLAB LVL
12.		450 HIGH KERB WALL
13.		115 THICK BRICK WALL IN PIPE SHAFT
14.	RWP	150mm ø MS RAIN WATER PIPE

BHEL-PROJECT ENGINEERING MANAGEMENT(CIVIL)
THIS DRAWING MARKED(✓) IS RELEASED FOR
☑ COMMENTS/APPROVAL
☐ PLANNING/INFORMATION
☐ CONSTRUCTION
STAMP ALL PREVIOUS REVISION AS SUPERSEDED

ISSUED BY	
NAME	MK MAHALA
SIGNATURE	–sd–
DATE	31.10.2025

REV.	DATE	ALTD	CHD	APPD
04	31.10.25	USHA	S.B	TMSR
	DRAWING REVISED AS PER CUSTOMER COMMENTS AND COMMENTS RECEIVED DURING VC MEETING HELD ON 17.10.2025 BETWEEN HPGCL, DCPL, DESEIN AND BHEL			
03	15.07.25	USHA	S.B	TMSR
	REVISED AS PER APPROVED 3–D PERSPECTIVE VIEW AND CUSTOMER COMMENTS			
02	07.02.25	USHA	S.B	MKM
	GENERALLY REVISED			
01	24.10.24	USHA	S.B	MKM
	REVISED AS PER CUSTOMER COMMENTS			

JOB NO. 510
STATUS CONTRACT
DISTRIBUTION

PROJECT
1X800 MW ULTRA SUPER CRITICAL EXPANSION UNIT, DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR

OWNER: HARYANA POWER GENERATION CORPORATION LTD.
OWNER'S CONSULTANT: DESEIN PRIVATE LIMITED, CONSULTING ENGINEERS, NEW DELHI
OWNER'S REVIEW CONSULTANT: DEVELOPMENT CONSULTANTS PVT. LTD., CONSULTING ENGINEERS, KOLKATA
EPC CONTRACTOR: BHARAT HEAVY ELECTRICALS LTD, NEW DELHI
BHEL UNIT: BHARAT HEAVY ELECTRICALS LTD, POWER SECTOR PROJECT ENGINEERING MANAGEMENT,NOIDA
SUB-SUPPLIER / SUB-VENDOR: XXXX

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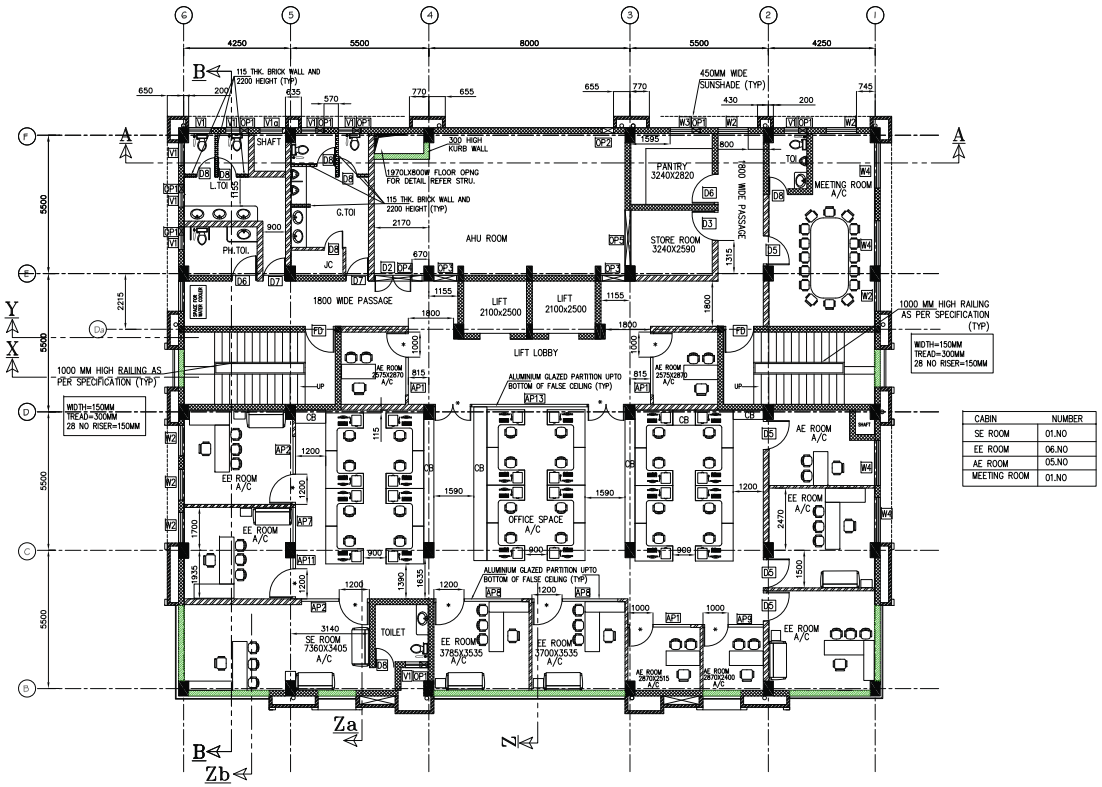
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	DESN	S.BAJPAI	–sd–	06.08.2024
	CHD	MKM	–sd–	06.08.2024
	APPD	AM	–sd–	06.08.2024

TITLE –
SERVICE BUILDING
ARCH. GA AT SECOND LEVEL

DEPT. | SCALE | DRAWING NO. PE-DG-510-640-C003
SIGN
SHEET 1 OF 1 REV. 04

Jul 18, 2026 – 4:54pm SIZE–A0

NORTH



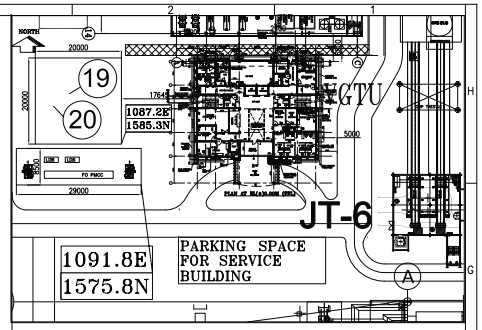
CABIN	NUMBER
SE ROOM	01.NO
EE ROOM	06.NO
AE ROOM	05.NO
MEETING ROOM	01.NO

PLAN AT EL(+)12.75 (FFL)

(ALL BRICK WALLS IN AC AREA SHALL BE UPTO BOTTOM OF FALSE CEILING LEVEL U.N.O.)
(ALL ALUMINIUM PARTITION IN AC AREA SHALL BE UPTO BOTTOM OF FALSE CEILING LEVEL)
(FALSE CEILING HEIGHT IS 2400MM U.N.O.)
(*) DOOR MARKED WITH (*) ARE PART OF ALUMINIUM PARTITION

OPENING SCHEDULE

OP1------330ø WALL OPENING, BOTTOM OF OPENING TO BE MATCHED WITH TOP OF LINTEL BEAM
OP2------450X450 WALL OPENING ,BOTTOM OF OPENING TO BE MATCHED WITH TOP OF LINTEL BEAM
OP3------900X750 WALL OPENING, TOP OF OPENING TO BE MATCHED WITH BOTTOM OF FLOOR BEAM
OP4------1900X750 WALL OPENING, TOP OF OPENING TO BE MATCHED WITH BOTTOM OF FLOOR BEAM
OP5------2200X750 WALL OPENING, TOP OF OPENING TO BE MATCHED WITH BOTTOM OF FLOOR BEAM



KEY PLAN

NOTES:–

1. ALL DIMENSIONS ARE IN MILLIMETERS EXCEPT FLOOR ELEVATIONS AND PLANT GRID WHICH ARE IN METERS, UNLESS STATED OTHERWISE.
2. EL(±)0.000 REFERS TO FINISHED FLOOR LEVEL OF POWER HOUSE BUILDING WHICH CORRESPONDS TO RL(+)270.500 M.
3. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH THE RELEVANT ARCHITECTURAL, CIVIL AND STRUCTURAL DRAWINGS, SPECIFICATIONS & SCHEDULE OF ITEMS.
4. TOILET INTERNAL WALL SHALL BE OF 115MM BRICK WORK AND 2200 MM HIGH.
5. DOOR MARKED AS (*) ARE PART OF ALUMINIUM PARTITION.
6. ANODIZED ALUMINIUM GRILL SHOULD BE PROVIDED TO ALL WINDOWS AT GROUND FLOOR.

REFERENCE DRAWINGS:–

1. SERVICE BLDG –ARCH .GA AT GROUND FLOOR LEVEL -----PE-DG-510-640-C001
2. SERVICE BLDG –ARCH .GA AT FIRST FLOOR LEVEL --------PE-DG-510-640-C002
3. SERVICE BLDG –ARCH .GA AT SECOND FLOOR LEVEL ------PE-DG-510-640-C003
4. SERVICE BLDG –ARCH .GA AT FOURTH FLOOR LEVEL ------PE-DG-510-640-C005
5. SERVICE BLDG –ARCH .GA AT ROOF LEVEL ----------PE-DG-510-640-C006

LEGENDS

S.NO	LEGEND	DESCRIPTION
1.	TYP.	TYPICAL
2.	THK.	THICK
3.	FFL	FINISH FLOOR LEVEL
4.	BOL	BOTTOM OF LINTEL
5.	LVL	LEVEL
6.	TOC	TOP OF CONCRETE
7.	TOP	TOP OF PARAPET WALL
8.	FGL	FINISHED GROUND LEVEL
9.		230 THICK BRICK WALL UPTO BOTTOM OF FALSE CEILING
10.		115 THK BRICK WALL UPTO 2200
11.		230 THICK BRICK WALL UPTO SLAB LVL
12.		450 HIGH KERB WALL
13.		115 THICK BRICK WALL IN PIPE SHAFT
14.	RWP	150mm ø MS RAIN WATER PIPE

BHEL-PROJECT ENGINEERING MANAGEMENT(CIVIL)
THIS DRAWING MARKED(✓) IS RELEASED FOR
☑ COMMENTS/APPROVAL
☐ PLANNING/INFORMATION
☐ CONSTRUCTION
STAMP ALL PREVIOUS REVISION AS SUPERSEDED

ISSUED BY	
NAME	MK MAHALA
SIGNATURE	–sd–
DATE	31.10.2025

PROJECT
1X800 MW ULTRA SUPER CRITICAL EXPANSION UNIT, DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR

OWNER: HARYANA POWER GENERATION CORPORATION LTD.
OWNER'S CONSULTANT: DESEIN PRIVATE LIMITED, CONSULTING ENGINEERS, NEW DELHI
OWNER'S REVIEW CONSULTANT: DEVELOPMENT CONSULTANTS PVT. LTD., CONSULTING ENGINEERS, KOLKATA
EPC CONTRACTOR: BHARAT HEAVY ELECTRICALS LTD, NEW DELHI
BHEL UNIT: BHARAT HEAVY ELECTRICALS LTD, POWER SECTOR PROJECT ENGINEERING MANAGEMENT,NOIDA
SUB-SUPPLIER / SUB-VENDOR: XXXX

JOB NO.	510
STATUS	CONTRACT
DISTRIBUTION	

REV.	DATE	ALTD	CHD	APPD	REMARKS
04	31.10.25	USHA	S.B	TMSR	DRAWING REVISED AS PER CUSTOMER COMMENTS AND COMMENTS RECEIVED DURING VC MEETING HELD ON 17.10.2025 BETWEEN HPGCL, DCPL, DESEIN AND BHEL
03	15.07.25	USHA	S.B	TMSR	REVISED AS PER APPROVED 3-D PERSPECTIVE VIEW AND CUSTOMER COMMENTS
02	07.02.25	USHA	S.B	MKM	GENERALLY REVISED
01	24.10.24	USHA	S.B	MKM	REVISED AS PER CUSTOMER COMMENTS

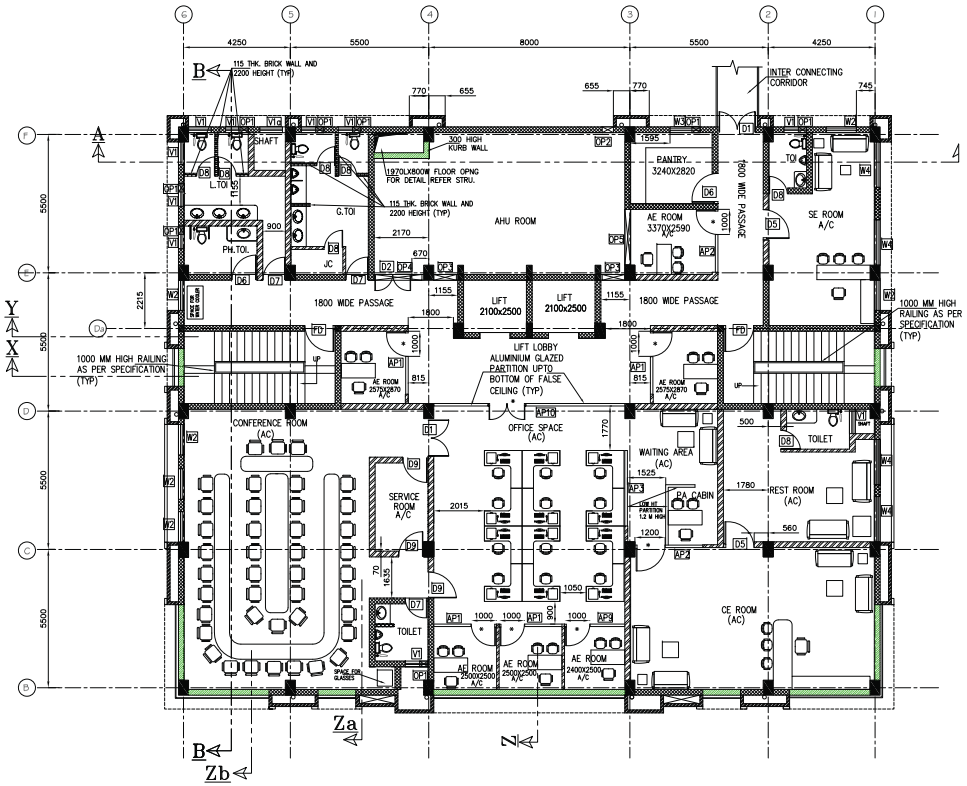
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DEPT CODE		NAME	SIGN	DATE
C	DRN	USHA	–sd–	06.08.2024
	DESN	S.BAJPAI	–sd–	06.08.2024
	CHD	MKM	–sd–	06.08.2024
	APPD	AM	–sd–	06.08.2024

TITLE –
SERVICE BUILDING
ARCH.GA AT THIRD LEVEL

DEPT. | SCALE | DRAWING NO. PE-DG-510-640-C004
SIGN
SHEET 1 OF 1 REV. 04

Jul 18, 2026 – 4:54pm SIZE–A0



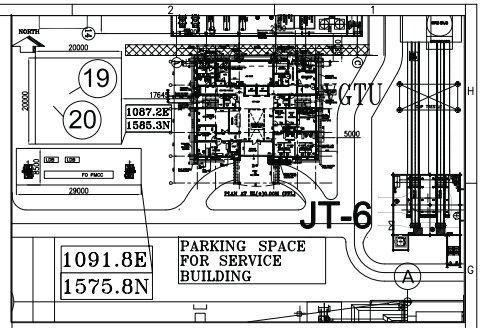
CABIN	NUMBER
SE ROOM	01.NO
EE ROOM	–
AE ROOM	06.NO
MEETING ROOM	–

PLAN AT EL(+)17.00 (FFL)

(ALL BRICK WALLS IN AC AREA SHALL BE UPTO BOTTOM OF FALSE CEILING LEVEL U.N.O.)
(ALL ALUMINIUM PARTITION IN AC AREA SHALL BE UPTO BOTTOM OF FALSE CEILING LEVEL)
(FALSE CEILING HEIGHT IS 2400MM U.N.O.)
(*) DOOR MARKED WITH (*) ARE PART OF ALUMINIUM PARTITION

OPENING SCHEDULE

OP1------330ø WALL OPENING, BOTTOM OF OPENING TO BE MATCHED WITH TOP OF LINTEL BEAM
OP2------450X450 WALL OPENING ,BOTTOM OF OPENING TO BE MATCHED WITH TOP OF LINTEL BEAM
OP3------900X750 WALL OPENING, TOP OF OPENING TO BE MATCHED WITH BOTTOM OF FLOOR BEAM
OP4------1900X750 WALL OPENING, TOP OF OPENING TO BE MATCHED WITH BOTTOM OF FLOOR BEAM
OP5------2200X750 WALL OPENING, TOP OF OPENING TO BE MATCHED WITH BOTTOM OF FLOOR BEAM



KEY PLAN

NOTES:–

1. ALL DIMENSIONS ARE IN MILLIMETERS EXCEPT FLOOR ELEVATIONS AND PLANT GRID WHICH ARE IN METERS, UNLESS STATED OTHERWISE.
2. EL(±)0.000 REFERS TO FINISHED FLOOR LEVEL OF POWER HOUSE BUILDING WHICH CORRESPONDS TO RL(+)270.500 M.
3. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH THE RELEVANT ARCHITECTURAL, CIVIL AND STRUCTURAL DRAWINGS, SPECIFICATIONS & SCHEDULE OF ITEMS.
4. TOILET INTERNAL WALL SHALL BE OF 115MM BRICK WORK AND 2200 MM HIGH.
5. DOOR MARKED AS (*) ARE PART OF ALUMINIUM PARTITION.
6. ANODIZED ALUMINIUM GRILL SHOULD BE PROVIDED TO ALL WINDOWS AT GROUND FLOOR.

REFERENCE DRAWINGS:–

1. SERVICE BLDG –ARCH .GA AT GROUND FLOOR LEVEL -----PE-DG-510-640-C001
2. SERVICE BLDG –ARCH .GA AT FIRST FLOOR LEVEL --------PE-DG-510-640-C002
3. SERVICE BLDG –ARCH .GA AT SECOND FLOOR LEVEL ------PE-DG-510-640-C003
4. SERVICE BLDG –ARCH .GA AT THIRD FLOOR LEVEL --------PE-DG-510-640-C004
5. SERVICE BLDG –ARCH .GA AT ROOF LEVEL ----------PE-DG-510-640-C006

LEGENDS

S.NO	LEGEND	DESCRIPTION
1.	TYP.	TYPICAL
2.	THK.	THICK
3.	FFL	FINISH FLOOR LEVEL
4.	BOL	BOTTOM OF LINTEL
5.	LVL	LEVEL
6.	TOC	TOP OF CONCRETE
7.	TOP	TOP OF PARAPET WALL
8.	FGL	FINISHED GROUND LEVEL
9.		230 THICK BRICK WALL UPTO BOTTOM OF FALSE CEILING
10.		115 THK BRICK WALL UPTO 2200
11.		230 THICK BRICK WALL UPTO SLAB LVL
12.		450 HIGH KERB WALL
13.		115 THICK BRICK WALL IN PIPE SHAFT
14.	RWP	150mm ø MS RAIN WATER PIPE

BHEL–PROJECT ENGINEERING MANAGEMENT(CIVIL)
THIS DRAWING MARKED(✓) IS RELEASED FOR
☑ COMMENTS/APPROVAL
☐ PLANNING/INFORMATION
☐ CONSTRUCTION
STAMP ALL PREVIOUS REVISION AS SUPERSEDED

ISSUED BY	
NAME	MK MAHALA
SIGNATURE	–sd–
DATE	31.10.2025

REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD
04	31.10.25	USHA	S.B	TMSR	03	15.07.25	USHA	S.B	TMSR	02	07.02.25	USHA	S.B	MKM	01	24.10.24	USHA	S.B	MKM
	DRAWING REVISED AS PER CUSTOMER COMMENTS AND COMMENTS RECEIVED DURING VC MEETING HELD ON 17.10.2025 BETWEEN HPGCL, DCPL, DESEIN AND BHEL					REVISED AS PER APPROVED 3–D PERSPECTIVE VIEW AND CUSTOMER COMMENTS					GENERALLY REVISED					REVISED AS PER CUSTOMER COMMENTS			

JOB NO. 510
STATUS CONTRACT
DISTRIBUTION

PROJECT
1X800 MW ULTRA SUPER CRITICAL EXPANSION UNIT, DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR

OWNER: HARYANA POWER GENERATION CORPORATION LTD.
OWNER'S CONSULTANT: DESEIN PRIVATE LIMITED, CONSULTING ENGINEERS, NEW DELHI
OWNER'S REVIEW CONSULTANT: DEVELOPMENT CONSULTANTS PVT. LTD., CONSULTING ENGINEERS, KOLKATA
EPC CONTRACTOR: BHARAT HEAVY ELECTRICALS LTD, NEW DELHI
BHEL UNIT: BHARAT HEAVY ELECTRICALS LTD, POWER SECTOR PROJECT ENGINEERING MANAGEMENT,NOIDA
SUB-SUPPLIER / SUB-VENDOR: XXXX

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DEPT CODE		NAME	SIGN	DATE
C	DRN	USHA	–sd–	06.08.2024
	DESN	S.BAJPAI	–sd–	06.08.2024
	CHD	MKM	–sd–	06.08.2024
	APPD	AM	–sd–	06.08.2024

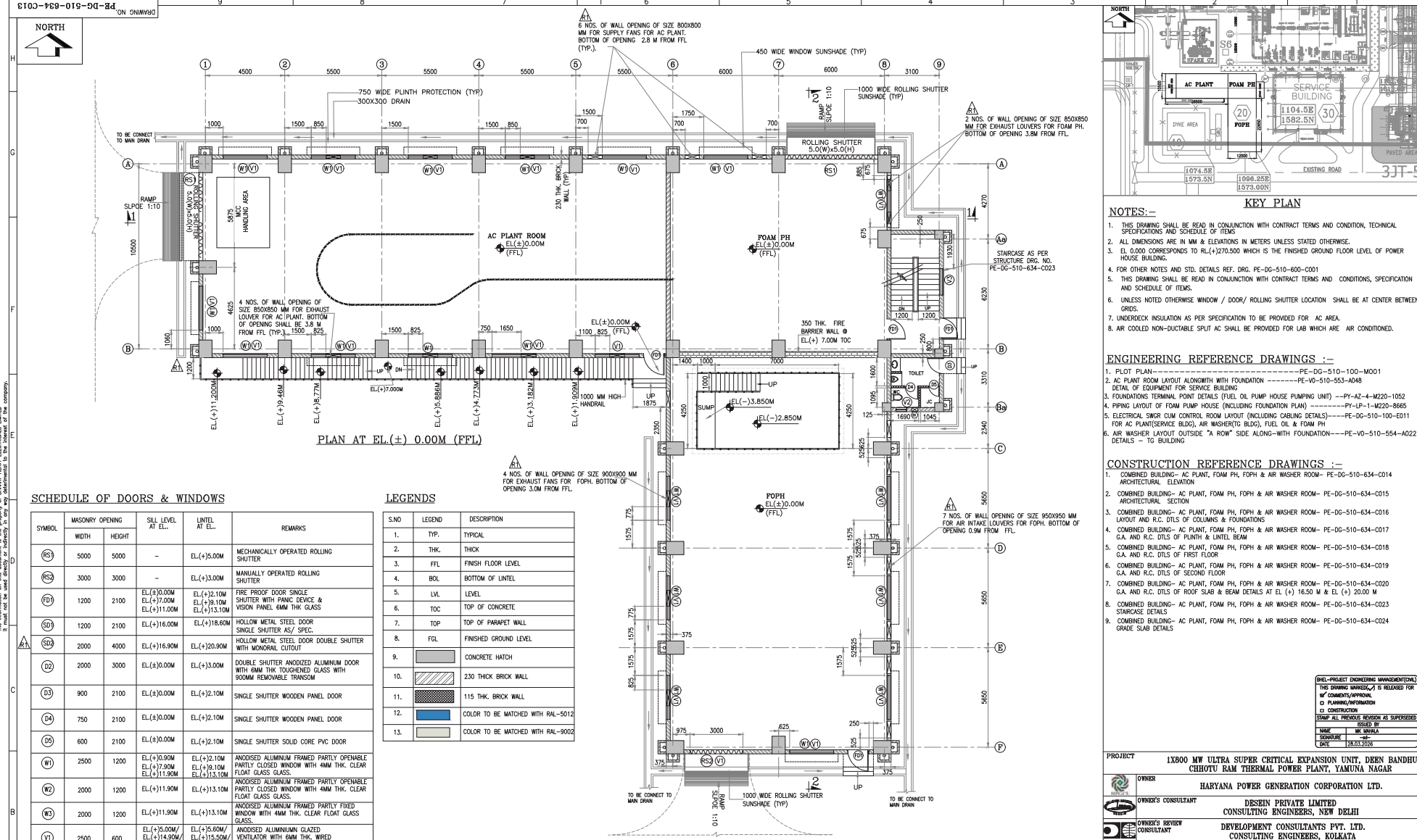
TITLE –
SERVICE BUILDING
ARCH.GA AT FOURTH LEVEL

DEPT. | SCALE | DRAWING NO. PE-DG-510-640-C005
SIGN
SHEET 1 OF 1 REV. 04

Jul 18, 2026 – 4:55pm SIZE–A0

DRAWING NO. PE-DG-510-634-C013

FIRST ANGLE PROJECTION | ALL DIMENSIONS ARE IN MM



PLAN AT EL.(±) 0.00M (FFL)

KEY PLAN

NOTES:–

1. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH CONTRACT TERMS AND CONDITION, TECHNICAL SPECIFICATIONS AND SCHEDULE OF ITEMS
2. ALL DIMENSIONS ARE IN MM & ELEVATIONS IN METERS UNLESS STATED OTHERWISE.
3. EL 0.000 CORRESPONDS TO RL-(+)270.500 WHICH IS THE FINISHED GROUND FLOOR LEVEL OF POWER HOUSE BUILDING.
4. FOR OTHER NOTES AND STD. DETAILS REF. DRG. PE-DG-510-600-C001
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7. UNDERDECK INSULATION AS PER SPECIFICATION TO BE PROVIDED FOR AC AREA.
8. AIR COOLED NON-DUCTABLE SPLIT AC SHALL BE PROVIDED FOR LAB WHICH ARE AIR CONDITIONED.

ENGINEERING REFERENCE DRAWINGS :–

1. PLOT PLAN----------PE-DG-510-100-M001
2. AC PLANT ROOM LAYOUT ALONGWITH WITH FOUNDATION --------PE-V0-510-553-A048 DETAIL OF EQUIPMENT FOR SERVICE BUILDING
3. FOUNDATIONS TERMINAL POINT DETAILS (FUEL OIL PUMP HOUSE PUMPING UNIT) --PY-AZ-4-M220-1052
4. PIPING LAYOUT OF FOAM PUMP HOUSE (INCLUDING FOUNDATION PLAN) ---------PY-LP-1-M220-8665
5. ELECTRICAL SWGR CUM CONTROL ROOM LAYOUT (INCLUDING CABLING DETAILS)----PE-DG-510-100-E011 FOR AC PLANT(SERVICE BLDG), AIR WASHER(TG BLDG), FUEL OIL & FOAM PH
6. AIR WASHER LAYOUT OUTSIDE "A ROW" SIDE ALONG-WITH FOUNDATION---PE-V0-510-554-A022 DETAILS – TG BUILDING

CONSTRUCTION REFERENCE DRAWINGS :–

1. COMBINED BUILDING– AC PLANT, FOAM PH, FOPH & AIR WASHER ROOM– PE-DG-510-634-C014 ARCHITECTURAL ELEVATION
2. COMBINED BUILDING– AC PLANT, FOAM PH, FOPH & AIR WASHER ROOM– PE-DG-510-634-C015 ARCHITECTURAL SECTION
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7. COMBINED BUILDING– AC PLANT, FOAM PH, FOPH & AIR WASHER ROOM– PE-DG-510-634-C020 G.A. AND R.C. DTLS OF ROOF SLAB & BEAM DETAILS AT EL (+) 16.50 M & EL (+) 20.00 M
8. COMBINED BUILDING– AC PLANT, FOAM PH, FOPH & AIR WASHER ROOM– PE-DG-510-634-C023 STAIRCASE DETAILS
9. COMBINED BUILDING– AC PLANT, FOAM PH, FOPH & AIR WASHER ROOM– PE-DG-510-634-C024 GRADE SLAB DETAILS

SCHEDULE OF DOORS & WINDOWS

SYMBOL	MASONRY OPENING WIDTH	MASONRY OPENING HEIGHT	SILL LEVEL AT EL..	LINTEL AT EL..	REMARKS
RS1	5000	5000	–	EL.(+)5.00M	MECHANICALLY OPERATED ROLLING SHUTTER
RS2	3000	3000	–	EL.(+)3.00M	MANUALLY OPERATED ROLLING SHUTTER
FD1	1200	2100	EL.(±)0.00M EL.(+)7.00M EL.(+)11.00M	EL.(+)2.10M EL.(+)9.10M EL.(+)13.10M	FIRE PROOF DOOR SINGLE SHUTTER WITH PANIC DEVICE & VISION PANEL 6MM THK GLASS
SD1	1200	2100	EL.(+)16.00M	EL.(+)18.60M	HOLLOW METAL STEEL DOOR SINGLE SHUTTER AS/ SPEC.
SD2	2000	4000	EL.(+)16.90M	EL.(+)20.90M	HOLLOW METAL STEEL DOOR DOUBLE SHUTTER WITH MONORAIL CUTOUT
D2	2000	3000	EL.(±)0.00M	EL.(+)3.00M	DOUBLE SHUTTER ANODIZED ALUMINUM DOOR WITH 6MM THK TOUGHENED GLASS WITH 900MM REMOVABLE TRANSOM
D3	900	2100	EL.(±)0.00M	EL.(+)2.10M	SINGLE SHUTTER WOODEN PANEL DOOR
D4	750	2100	EL.(±)0.00M	EL.(+)2.10M	SINGLE SHUTTER WOODEN PANEL DOOR
D5	600	2100	EL.(±)0.00M	EL.(+)2.10M	SINGLE SHUTTER SOLID CORE PVC DOOR
W1	2500	1200	EL.(+)0.90M EL.(+)7.90M EL.(+)11.90M	EL.(+)2.10M EL.(+)9.10M EL.(+)13.10M	ANODISED ALUMINUM FRAMED PARTLY OPENABLE PARTLY CLOSED WINDOW WITH 4MM THK. CLEAR FLOAT GLASS GLASS.
W2	2000	1200	EL.(+)11.90M	EL.(+)13.10M	ANODISED ALUMINUM FRAMED PARTLY OPENABLE PARTLY CLOSED WINDOW WITH 4MM THK. CLEAR FLOAT GLASS GLASS.
W3	2000	1200	EL.(+)11.90M	EL.(+)13.10M	ANODISED ALUMINUM FRAMED PARTLY FIXED WINDOW WITH 4MM THK. CLEAR FLOAT GLASS GLASS.
V1	2500	600	EL.(+)5.00M/ EL.(+)14.90M/ EL.(+)8.90M/	EL.(+)5.60M/ EL.(+)15.50M/ EL.(+)9.30M/	ANODISED ALUMINUMN GLAZED VENTILATOR WITH 6MM THK. WIRED GLASS.
V2	600	600	EL.(+)1.80M	EL.(+)2.40M	ANODISED ALUMINUMN GLAZED VENTILATOR WITH 6MM THK. WIRED GLASS.
V3	1500	600	EL.(+)5.40M/ EL.(+)9.40M/ EL.(+)13.50M/	EL.(+)6.00M/ EL.(+)10.00M/ EL.(+)14.10M/	ANODISED ALUMINUMN GLAZED VENTILATOR WITH 6MM THK. WIRED GLASS.
EX	---------- 330Φ OPENING FOR EXHAUST FAN.				

LEGENDS

S.NO	LEGEND	DESCRIPTION
1.	TYP.	TYPICAL
2.	THK.	THICK
3.	FFL	FINISH FLOOR LEVEL
4.	BOL	BOTTOM OF LINTEL
5.	LVL	LEVEL
6.	TOC	TOP OF CONCRETE
7.	TOP	TOP OF PARAPET WALL
8.	FGL	FINISHED GROUND LEVEL
9.		CONCRETE HATCH
10.		230 THICK BRICK WALL
11.		115 THK. BRICK WALL
12.		COLOR TO BE MATCHED WITH RAL-5012
13.		COLOR TO BE MATCHED WITH RAL-9002

BHEL-PROJECT ENGINEERING MANAGEMENT(CIVIL)
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☐ PLANNING/INFORMATION
☐ CONSTRUCTION
STAMP ALL PREVIOUS REVISION AS SUPERSEDED

ISSUED BY	
NAME	MK MAHLA
SIGNATURE	–sd–
DATE	28.03.2026

PROJECT: 1X800 MW ULTRA SUPER CRITICAL EXPANSION UNIT, DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR

OWNER: HARYANA POWER GENERATION CORPORATION LTD.

OWNER'S CONSULTANT: DESEIN PRIVATE LIMITED CONSULTING ENGINEERS, NEW DELHI

OWNER'S REVIEW CONSULTANT: DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS, KOLKATA

EPC CONTRACTOR: BHARAT HEAVY ELECTRICALS LTD, NEW DELHI

BHEL UNIT: BHARAT HEAVY ELECTRICALS LTD, POWER SECTOR PROJECT ENGINEERING MANAGEMENT,NOIDA

SUB-SUPPLIER / SUB-VENDOR: XXXX

JOB NO.	510			
STATUS	CONTRACT			
DISTRIBUTION				
REV.	DATE	ALTD	CHD	APPD
01	28.03.2026	VEENA	VK	Dr.A.DAS

CUSTOMER COMMENTS AND FAN OPENING INCORPORATED & REVISED & AS MKD.

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C	DRN	VEENA	–sd–	28.01.2026
	DESN	VK	–sd–	28.01.2026
	CHD	MKM	–sd–	28.01.2026
	APPD	Dr. A Das	–sd–	28.01.2026

TITLE:– COMBINED BUILDING
AC PLANT, FOAM PH, FOPH & AIR WASHER–ARCHITECTURAL PLAN

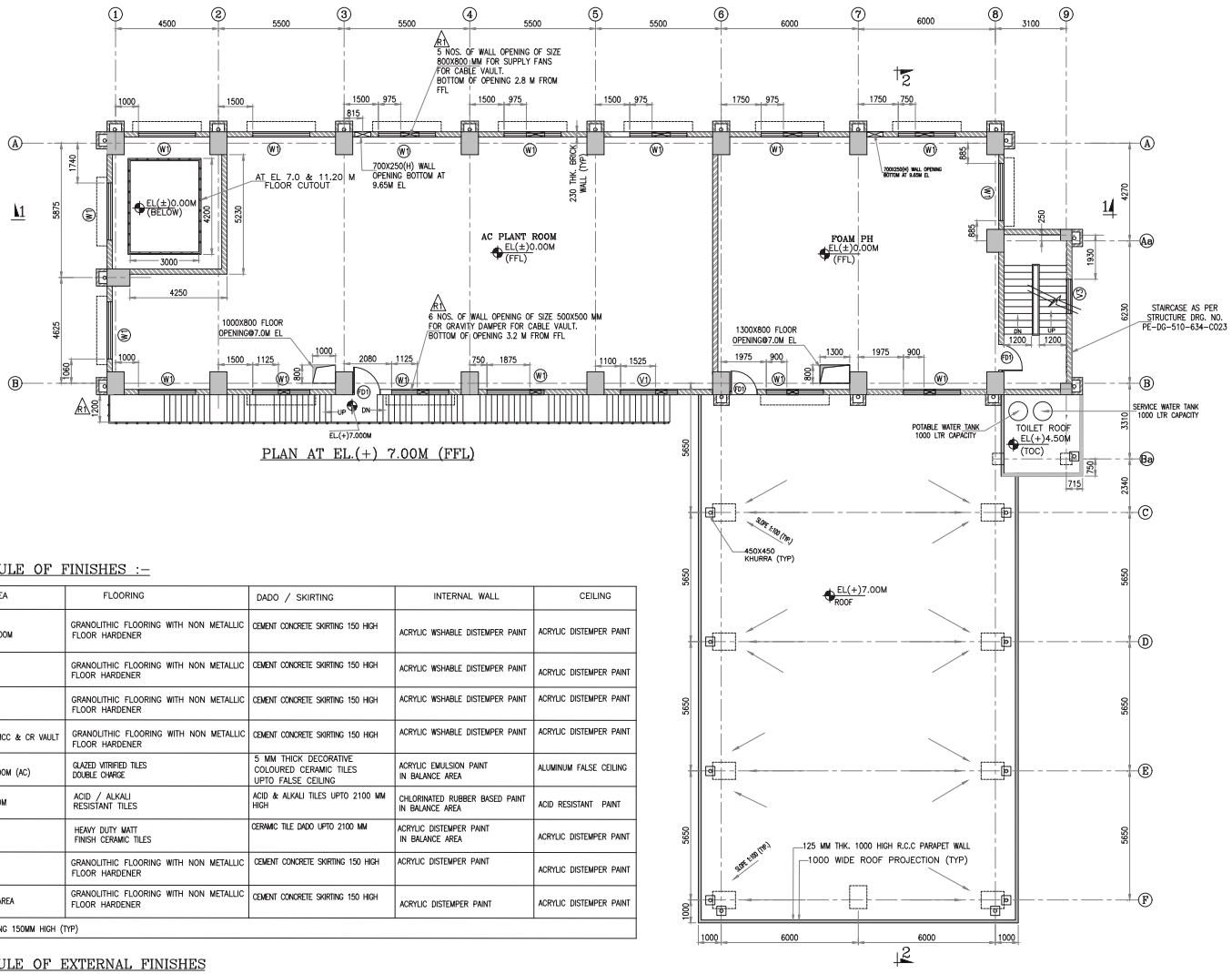
DEPT. | SCALE | SIGN

DRAWING NO. PE-DG-510-634-C013

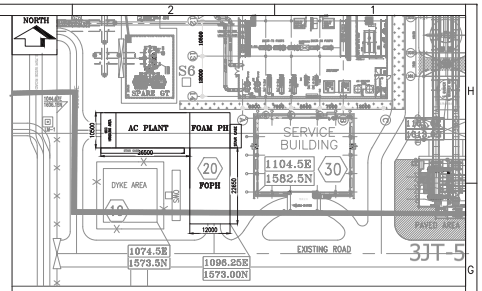
SHEET 1 OF 3 | REV. 01

Mar 28, 2026 – 5:19pm | SIZE-A0

Page 1 of 3
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PLAN AT EL.(+) 7.00M (FFL)



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6. AIR WASHER LAYOUT OUTSIDE "A ROW" SIDE ALONG--WITH FOUNDATION---PE-VO-510-554-A022 DETAILS – TG BUILDING

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9. COMBINED BUILDING– AC PLANT, FOAM PH, FOPH & AIR WASHER ROOM– PE-DG-510-634-C024 GRADE SLAB DETAILS

SCHEDULE OF FINISHES :–

AREA	FLOORING	DADO / SKIRTING	INTERNAL WALL	CEILING
AC PLANT ROOM	GRANOLITHIC FLOORING WITH NON METALLIC FLOOR HARDENER	CEMENT CONCRETE SKIRTING 150 HIGH	ACRYLIC WSHABLE DISTEMPER PAINT	ACRYLIC DISTEMPER PAINT
FOAM PH	GRANOLITHIC FLOORING WITH NON METALLIC FLOOR HARDENER	CEMENT CONCRETE SKIRTING 150 HIGH	ACRYLIC WSHABLE DISTEMPER PAINT	ACRYLIC DISTEMPER PAINT
FOPH	GRANOLITHIC FLOORING WITH NON METALLIC FLOOR HARDENER	CEMENT CONCRETE SKIRTING 150 HIGH	ACRYLIC WSHABLE DISTEMPER PAINT	ACRYLIC DISTEMPER PAINT
ELECTRICAL MCC & CR VAULT	GRANOLITHIC FLOORING WITH NON METALLIC FLOOR HARDENER	CEMENT CONCRETE SKIRTING 150 HIGH	ACRYLIC WSHABLE DISTEMPER PAINT	ACRYLIC DISTEMPER PAINT
CONTROL ROOM (AC)	GLAZED VITRIFIED TILES DOUBLE CHARGE	5 MM THICK DECORATIVE COLOURED CERAMIC TILES UPTO FALSE CEILING	ACRYLIC EMULSION PAINT IN BALANCE AREA	ALUMINUM FALSE CEILING
BATTERY ROOM	ACID / ALKALI RESISTANT TILES	ACID & ALKALI TILES UPTO 2100 MM HIGH	CHLORINATED RUBBER BASED PAINT IN BALANCE AREA	ACID RESISTANT PAINT
TOILET	HEAVY DUTY MATT FINISH CERAMIC TILES	CERAMIC TILE DADO UPTO 2100 MM	ACRYLIC DISTEMPER PAINT IN BALANCE AREA	ACRYLIC DISTEMPER PAINT
STAIRCASE	GRANOLITHIC FLOORING WITH NON METALLIC FLOOR HARDENER	CEMENT CONCRETE SKIRTING 150 HIGH	ACRYLIC DISTEMPER PAINT	ACRYLIC DISTEMPER PAINT
ALL OTHER AREA	GRANOLITHIC FLOORING WITH NON METALLIC FLOOR HARDENER	CEMENT CONCRETE SKIRTING 150 HIGH	ACRYLIC DISTEMPER PAINT	ACRYLIC DISTEMPER PAINT
NOTE–SKIRTING 150MM HIGH (TYP)				

SCHEDULE OF EXTERNAL FINISHES

RWP	150mm ø MS RAIN WATER PIPE.(TYP)
EXTERIOR PLASTERING	20 MM THK. WITH 1:4 CEMENT SAND MORTAR
INTERIOR PLASTERING	12MM WITH 1:3 CEMENT SAND MORTAR
CEILING PLASTERING	6MM WITH 1:3 CEMENT SAND MORTAR
EXTERIOR FINISHING	WATER PROOF CEMENT BASED PAINT.

BHEL-PROJECT ENGINEERING MANAGEMENT(CML)

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- ☑ COMMENTS/APPROVAL
- ☐ PLANNING/INFORMATION
- ☐ CONSTRUCTION

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ISSUED BY	
NAME	MK MAHAJA
SIGNATURE	–sd–
DATE	28.03.2026

PROJECT	1X800 MW ULTRA SUPER CRITICAL EXPANSION UNIT, DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR
OWNER	HARYANA POWER GENERATION CORPORATION LTD.
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EPC CONTRACTOR	BHARAT HEAVY ELECTRICALS LTD, NEW DELHI
BHEL UNIT	BHARAT HEAVY ELECTRICALS LTD, POWER SECTOR PROJECT ENGINEERING MANAGEMENT,NOIDA
SUB-SUPPLIER / SUB-VENDOR	XXXX

JOB NO.	510
STATUS	CONTRACT
DISTRIBUTION	

REV.	DATE	ALTD	CHD	APPD
01	28.03.2026	VEENA	VK	Dr.A.DAS

CUSTOMER COMMENTS AND FAN OPENING INCORPORATED & REVISED & AS MKD.

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	DESN	VK	–sd–	28.01.2026
	CHD	MKM	–sd–	28.01.2026
	APPD	Dr. A Das	–sd–	28.01.2026

TITLE:–

COMBINED BUILDING

AC PLANT, FOAM PH, FOPH & AIR WASHER–ARCHITECTURAL PLAN

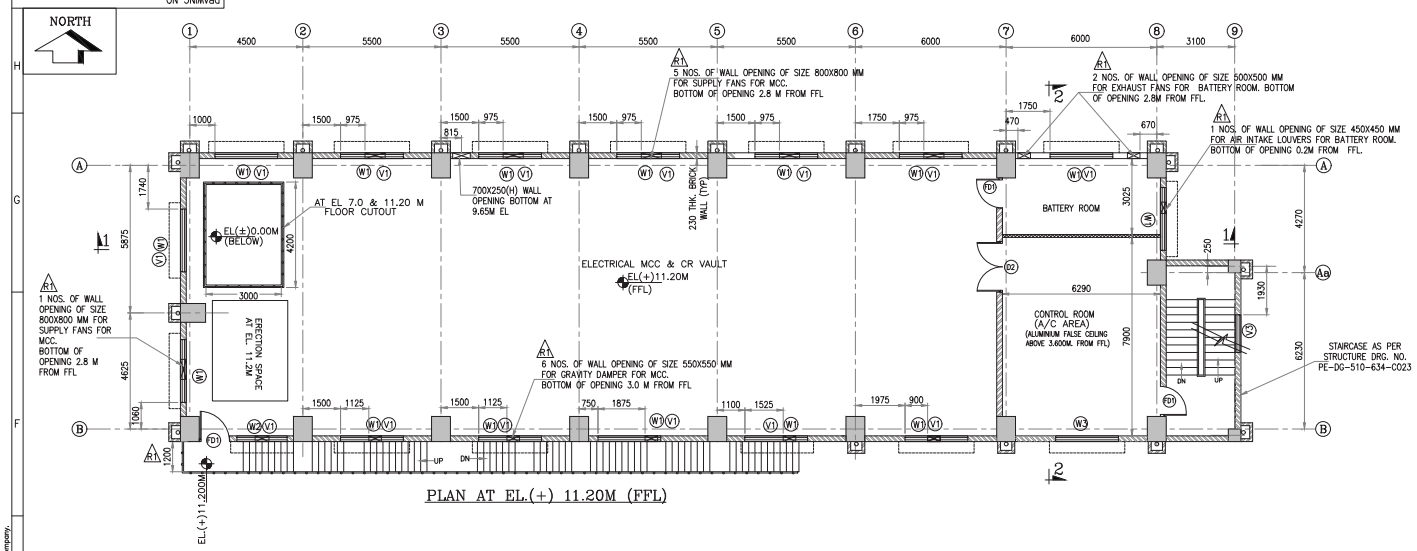
DEPT.	SCALE	DRAWING NO.
SIGN		PE-DG-510-634-C013

SHEET 2 OF 3 REV. 01

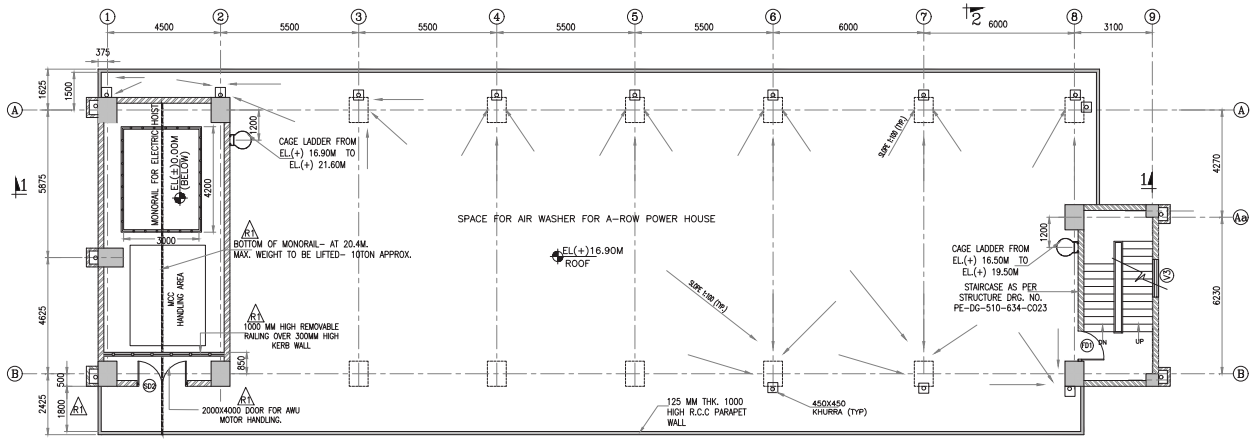
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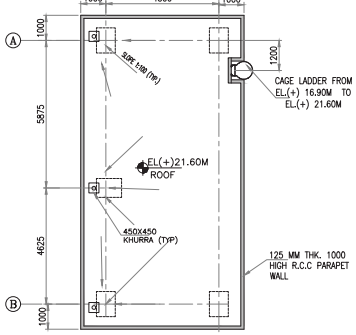
Page 562 of 563



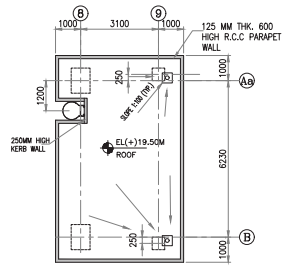
PLAN AT EL.(+) 11.20M (FFL)



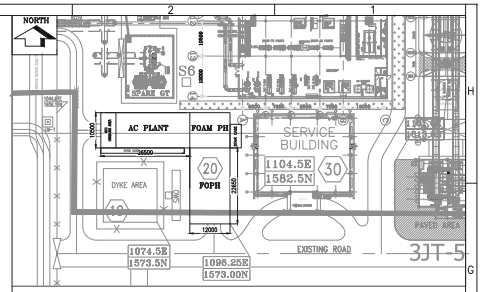
ROOF PLAN AT EL.(+) 16.90M (TOC)



PLAN AT EL.(+) 21.60M (TOC)



PLAN AT EL.(+) 19.50M (TOC)



KEY PLAN

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BHEL-PROJECT ENGINEERING MANAGEMENT(CML)
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- [ ] PLANNING/INFORMATION
- [ ] CONSTRUCTION

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NAME	MK MAHAJA
SIGNATURE	-sd-
DATE	28.03.2026

PROJECT	1X800 MW ULTRA SUPER CRITICAL EXPANSION UNIT, DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR
OWNER	HARYANA POWER GENERATION CORPORATION LTD.
OWNER'S CONSULTANT	DESEIN PRIVATE LIMITED CONSULTING ENGINEERS, NEW DELHI
OWNER'S REVIEW CONSULTANT	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS, KOLKATA
EPC CONTRACTOR	BHARAT HEAVY ELECTRICALS LTD, NEW DELHI
BHEL UNIT	BHARAT HEAVY ELECTRICALS LTD, POWER SECTOR PROJECT ENGINEERING MANAGEMENT,NOIDA
SUB-SUPPLIER / SUB-VENDOR	XXXX

JOB NO.	510
STATUS	CONTRACT
DISTRIBUTION	

REV.	DATE	ALTD	CHD	APPD
01	28.03.2026	VEENA	VK	Dr.A.DAS

CUSTOMER COMMENTS AND FAN OPENING INCORPORATED & REVISED & AS MKD A1

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DEPT CODE		NAME	SIGN	DATE
C	DRN	VEENA	-sd-	28.01.2026
	DESN	VK	-sd-	28.01.2026
	CHD	MKM	-sd-	28.01.2026
	APPD	Dr. A Das	-sd-	28.01.2026

TITLE:-
COMBINED BUILDING
AC PLANT, FOAM PH, FOPH & AIR WASHER-ARCHITECTURAL PLAN

DEPT.	SCALE	DRAWING NO.
SIGN		PE-DG-510-634-C013

SHEET 3 OF 3 REV. 01

Mar 28, 2026 - 5:20pm SIZE-A0

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